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No. 1826.] *FRIDAY, NOVEMBER* 18, 1887. [*Vol. XXXVI.*

ONE-HUNDRED-AND-THIRTY-FOURTH SESSION, 1887-88.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Thirty-fourth Session of the Society was held on Wednesday evening, the 16th November, when the Opening Address was delivered by Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, for which the following arrangements have been made :—

November 23.—Prof. Silvanus P. Thompson, "The Mercurial Air-pump." William Crookes, F.R.S., will preside.

" 30.—J. B. Hannay, "Economical Illumination from Waste Oils." Admiral Sir E. A. Inglefield, K.C.B., will preside.

December 7.—P. L. Simmonds, "The Chemistry, Commerce, and Uses of Eggs of various kinds."

" 14.—Sir Philip Magnus, "Commercial Education."

For Meetings after Christmas:—

PROF. JOHN WRIGHTSON, "Technical Instruction in Agriculture."
JOHN W. URQUHART, "Machine Tools for Boot and Shoe Manufacture."
W. T. ROWLETT, "Framework Knitting."
SAMUEL CHATWOOD, "Locks and Safes."
SIR HOWARD GRUBB, F.R.S., "Telescopes for Stellar Photography."
PROF. GEORGE FORBES, F.R.S., "The Measurement of Electrical Currents."
W. LANT CARPENTER, B.A., B.Sc., "The Continuation of Elementary Education."
JOHN HARRISON, "Type-writers and Type-writing."
WALTER EMDEN, "Theatres and Fireproof Construction."
JOHN LEIGHTON and JAMES WITHERS, "Methods of taking the Ballot." (Two papers.)

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday evenings at Eight o'clock:—
January 17; February 7; March 6, 27; April 17; May 15.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—
January 27; February 10, 24; March 16; April 13; May 4.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—
January 31; February 14; March 20; April 24; May 8, 29.

CANTOR LECTURES.

The First Course will be on "The Elements of Architectural Design." By H. H. STATHAM.

LECTURE I.—NOVEMBER 28.—Definition of architecture.—Its range and capability as an art.—Position in relation to other forms of art.—The architectural problem fourfold.—The plan.—The building up.—The covering in.—The decorative treatment.—Method of delineating an architectural design by geometrical drawings.—Relation of plan to exterior design.—The question of proportion.—Plan in itself a form of artistic expression.—Examples.

LECTURE II.—DECEMBER 5.—Influence of the mode of covering in on the general design.—The two systems of covering spaces, the beam and the arch.—Definition of "style."—Statical conditions of the beam system.—Its architectural expression as worked out by the Greeks.—The column.—The entablature.—The three styles employed by the Greeks.—The superstition of the "Five Orders."—Roman and Renaissance application of Greek forms.—Value of ancient classical forms to modern architecture.

LECTURE III.—DECEMBER 12.—The statical conditions of the arched method of covering.—Distinction between the column and the buttress.—The "waggon" vault.—The dome and domed architecture.—The development of the vault.—Transition from Romanesque to pointed architecture.—Constructive origin of the pointed arch.—Its development into the complete Gothic style.—Comparative analysis of Greek and Gothic styles.

LECTURE IV.—DECEMBER 19.—Architectural decoration.—Of two classes, moulded surfaces and carving.—The function of mouldings in architectural expression.—Their relation to material and climate.—Decorative carving.—Also influenced by material.—Its relation to nature and natural forms.—Applied decoration.—Architecture in cities.—Effective arrangements of sites.—Architecture and landscape.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON. Four Lectures.
January 30; February 6, 13, 20.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.
February 27; March 5.

The Fourth Course will be on "Alloys." By Prof. W. CHANDLER ROBERTS-AUSTEN, F.R.S Three Lectures.
March 12, 19, 26.

The Fifth Course will be on "Milk Supply and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

JUVENILE LECTURES.

Two Juvenile Lectures on "The Application of Electricity to Lighting and Working," by WILLIAM HENRY PREECE, F.R.S., will be given on Wednesday evenings, January 4 and 11, 1888, at Seven o'clock.

DR. MANN LECTURES.

Two Lectures will be delivered in the course of the Session on the "Protection of Buildings from Lightning," by Professor OLIVER J. LODGE, F.R.S. These lectures will be given as a memorial of the late Dr. Mann, and their cost will be defrayed by Mrs. Mann.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886 for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of from Three to Six Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Political and Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled :—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge ; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election ; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, H. T. Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C

H. TRUEMAN WOOD, *Secretary*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1887-8. It is issued subject to any necessary alterations:—

NOVEMBER, 1887.		
1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	Ordinary Meeting (Opening Meeting of the Session)
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture I. 1
29	Tu	
30	W	Ordinary Meeting

DECEMBER, 1887.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture I. 2
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	Cantor Lecture I. 3
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	
17	S	
18	**S**	
19	M	Cantor Lecture I. 4
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	Christmas Day
26	M	*Bank Holiday*
27	Tu	
28	W	
29	Th	
30	F	
31	S	

JANUARY, 1888.		
1	**S**	
2	M	
3	Tu	
4	W	Juvenile Lecture 1
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	Juvenile Lecture 2
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	For. & Col. Section
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	Indian Section
28	S	
29	**S**	
30	M	Cantor Lecture II. 1
31	Tu	Applied Art Section

FEBRUARY, 1888.		
1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture II. 2
7	Tu	For. & Col. Section
8	W	Ordinary Meeting
9	Th	
10	F	Indian Section
11	S	
12	**S**	
13	M	Cantor Lecture II. 3
14	Tu	Applied Art Section
15	W	Ordinary Meeting
16	Th	
17	F	
18	S	
19	**S**	
20	M	Cantor Lecture II. 4
21	Tu	
22	W	Ordinary Meeting
23	Th	
24	F	Indian Section
25	S	
26	**S**	
27	M	Cantor Lecture III. 1
28	Tu	
29	W	Ordinary Meeting

MARCH, 1888.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture III. 2
6	Tu	For. & Col. Section
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	Cantor Lecture IV. 1
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	Indian Section
17	S	
18	**S**	
19	M	Cantor Lecture IV. 2
20	Tu	Applied Art Section
21	W	Ordinary Meeting
22	Th	
23	F	
24	S	
25	**S**	
26	M	Cantor Lecture IV. 3
27	Tu	For. & Col. Section
28	W	
29	Th	
30	F	Good Friday
31	S	

APRIL, 1888.		
1	**S**	Easter Sunday
2	M	*Bank Holiday*
3	Tu	
4	W	
5	Th	
6	F	
7	S	
8	**S**	
9	M	Cantor Lecture V. 1
10	Tu	
11	W	Ordinary Meeting.
12	Th	
13	F	Indian Section
14	S	
15	**S**	
16	M	Cantor Lecture V. 2
17	Tu	For. & Col. Section
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture V. 3
24	Tu	Applied Art Section
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture VI. 1

MAY, 1888.		
1	Tu	
2	W	Ordinary Meeting
3	Th	
4	F	Indian Section
5	S	
6	**S**	
7	M	Cantor Lecture VI. 2
8	Tu	Applied Art Section
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture VI. 3
15	Tu	For. & Col. Section
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	Whit Sunday
21	M	*Bank Holiday*
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	
29	Tu	Applied Art Section
30	W	Ordinary Meeting
31	Th	

JUNE, 1888.		
1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	
14	Th	
15	F	
16	S	
17	**S**	
18	M	
19	Tu	
20	W	Annual Conversazione (probable date)
21	Th	
22	F	
23	S	
24	**S**	
25	M	
26	Tu	
27	W	Annual General Meeting
28	Th	
29	F	
30	S	

The chair will be taken at eight o'clock at each of the above meetings, except the Annual General Meeting and the Juvenile Lectures.

The Annual General Meeting will be held at four o'clock.

The Juvenile Lectures will be given at seven o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 16th, 1887; Sir DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ainge, Thomas Styles, Municipal-buildings, Liverpool.
Anderson, John, Town-hall, Montrose, N.B.
Anstruther, Lieut. Sir Ralph William, Bart., R.E., South Camp, Aldershot, and Balcaskie, Pittenweem, N.B.
Aulagnier, Louis E., 27, King-street, Covent-garden, W.C.
Bailey, Frank, Electric Light Works, Westbourne-bridge, Paddington, W.
Bapty, Samuel Lee, 36, Manor-road, Brockley, S.E.
Bayley, Edward Hodson, 42, Newington-causeway, S.E.
Bell, John Charles, Langbaurgh-hall, Great Ayton, Yorkshire.
Belton, Charles, Cartlands, Cookham Dean, Berks., and Junior Carlton Club, S.W.
Berry, Ernest Gower, 8, Wardour-street, Soho, W.
Bill, Henry, 155, Fenchurch-street, E.C., and 10, Strathmore-gardens, Kensington, W.
Butler, William Butler, 14, New Burlington-street, W.
Cassell, James Robert, 11, Billiter-square, E.C.
Crewe, Hugo Harpur, Spring-hill, East Cowes, Isle of Wight, and Windham Club, St. James's-square, S.W.
Croft, George C., 6, Stanhope-street, Hyde-park-gardens, W.
Crook, Charles Alexander, Enderby's Wharf, East Greenwich, S.E.
Drake, Bernard Mervyn, 2, Prince's-mansions, Victoria-street, S.W.
Draper, Alfred C. S., 40, Weston-street, Southwark, S.E., and 21, Russell-square, W.C.
Ely, Marquis of, Kearsney Abbey, near Dover, Kent.
Foster, Harry Seymour, Glenhurst, West Dulwich, S.E., and City Carlton Club, E.C.
Foster, William Joseph, 21, Birchin-lane, E.C., and 42, Hogarth-road, South Kensington, S.W.
Fothergill, Joseph, Tynemouth, Northumberland.
Harrison, George Howard, 4, Great George-street, S.W., and Hampton Wick, Surrey.
Hartel, Adolph, The Hermitage, Ravenscourt-park, Hammersmith, W.
Hodgson, James Stewart, 8, Bishopsgate-street Within, E.C.
Holland, Colonel James, Southside, The Park, Upper Norwood, S.E.
Hood, Henry J., M.A., 115, St. George's-road, S.W.
Hopkins, Edward Martin, 3, Upper Berkeley-street, W.
Johnson, Joseph William, Beau Manor, Maidstone.
Jonas, Lewis E., 63 Finchley-road, N.W.
Lees, Samuel, Park-bridge, Ashton-under-Lyne.
Lysons, General Sir Daniel, G.C.B., 22, Warwick-square, S.W.
McGarel-Hogg, Hon. Archibald Campbell, 17, Grosvenor-gardens, S.W.
McGavin, Ebenezer William, 8, Great Winchester-street, E.C.
Mapp, Paul Frederick W., Friars of St. Julian, Shrewsbury, Salop.
Margetts, William George, 21, Calverley-park, Tunbridge Wells, and St. Stephen's Club, S.W.
Morton, G. H., jun., London-road, Liverpool.
Mukerji, Satya Chandra, M.A., Mathura, N.W.P., India.
Nin, His Excellency Dr. Alberto, 19, Gloucester-place, Portman-square, W.
Norman, Leo J. N., 21, Mincing-lane, E.C., and Junior Travellers' Club, Piccadilly, W.
Owen, Hugh Gwynne, 17, Cavendish-place, W., and Salisbury Club, St. James's-square, S.W.
Oxenham, Edward Lavington, Nutcombe-house, Weybridge, Surrey.
Paine, George William, Cotswold-lodge, Farquhar-road, Upper Norwood, S.E.
Pegler, Oliver, Bledington, near Chipping Norton, Oxon.
Pincott, James, Tellham-house, Brixton-hill, S.W.
Ram, Diwan Doulat, 128, Lancaster-road, Notting-hill, W.
Rankin, William, Tiernaleague, Carndonagh, Co. Donegal.
Rapley, Frederick Harvey, Dashwood-house, 9, New Broad-street, E.C.
Reed, Albert E., 21, St. Andrew's-crescent, Cardiff.
Robinson, Frederick A., 7, Queen Elizabeth-avenue, Lordship-park, N.
Sadler, George, Brooklyn-house, Clapham-road, S.W.
Schroller, William, 2, Belmont-terrace, Dickenson-road, Rusholme, Manchester.
Self, James, M.D., Fairview, Farncombe-road, Worthing.
Silley, Abraham, 17, Craven-street, Strand, W.C.
Skliros, George Eustace, M.A., B.Sc., 291, Regent-street, W.
Smith, Captain John Henderson, R.N.R., H.M.S. *Worcester*, Greenhithe, Kent.
Tamini, Luis B., 5, Copthall-buildings, E.C., and 5, Park-road, Regent's-park, N.W.
Taylor, Robert Henry, Regent-house, Wilson-grove, Southsea.
Thompson, Richard Charles, Woodside, Sunderland.

Waldo - Sibthorp, Colonel Francis Richard, 41, Sillwood-road, Brighton.
Walker, Robert James, Woodside, Leicester.
Wright, John, 120, Malpas-road, Brockley, S.E.

The CHAIRMAN delivered the following

ADDRESS.

In my Address to the Society of Arts at the opening meeting of last year, I endeavoured to give you a short summary of the progress which had been made in sanitation during the Queen's reign. I think that as the Chairman of your Council is elected for a second year, it may be considered a fitting sequel to that Address to draw attention to some of the important matters which the Society has been instrumental in initiating or promoting, and which still remain to be effected. The questions to which I refer may be ranged under the heads of Education and Sanitation.

There have recently been placed before the public in a condensed form selections from the works of three of the pioneers of social progress, who began their campaign in the early part of the Queen's reign, viz., Edwin Chadwick, John Simon, and Henry Cole; all distinguished members of this Society, and all men whose efforts have had an important influence in raising the people from a condition which we should now term one of semi-barbarism. Those publications, each in its respective way, point out the nature of some of the social problems which had to be worked out.

In the great question of poor relief, Mr. Chadwick found that the old Poor-law contributed to make the condition of a pauper more eligible in all material respects than the condition of an independent labourer, and his efforts were directed towards altering the law so as to remove this anomaly.

In the important question of local administration Mr. Chadwick showed the advantage of large areas as compared with small areas in the administration of poor relief, and the necessity and economy of unity of administration in sanitation as well as in other matters of local self-government.

Sir John Simon, taking his text from the materials collected by Dr. Farr, conducted a series of detailed researches into the disease causes of the manufacturing and rural populations, by means of which he has been instrumental in enabling a large saving of life to be effected in our cities.

Sir Henry Cole's name is indelibly connected with efforts for the promotion of industrial art, his object having been not only to improve technical skill, but also to promote a taste for humane pleasures and a perception of the beautiful, and thus by degrees to soften and to brighten what would otherwise be a dull, hard world.

The legislation which has taken place in the last decade has brought, as its natural consequence, a vast amount of attention to many of these questions, because they affect the necessities and the enjoyments of those classes which have lately been enfranchised. A large number of proposals are now daily brought forward which are intended to improve the condition of the lower classes, both morally and physically, as, for instance, the authoritative regulation of the condition of their abodes and surroundings, the training and education of their children, the control of their habits of life, the encouragement of a desire for thrift. All these matters indicate that the social changes which have taken place during the first fifty years of Queen Victoria's reign are but a small instalment of the changes which, possibly not I, but the younger members of this generation, may see accomplished.

The simple doctrine of *laissez faire*, which many eminent philosophers and political economists since the beginning of the century have enunciated as an efficient solution of social problems, must be construed in connection with the old legal axiom, *sic utere tuo ut alieno non lædas*, to make it adaptable to the condition of a large population.

It is necessary that where large masses are congregated together, the proceedings of the individual should be so restrained as not to interfere with the health and comfort of those around him. All modern social legislation, including the early Factory Acts, the Education Acts, and, indeed, the latest Acts for notification of diseases, are the outcome of this practical axiom.

Our sanitary difficulties are simply the result of the neglect of communities in past times to regulate the conditions of life in each village and town as it grew up, by enforcing rules which would ensure that every dwelling should be so arranged as to maintain a pure soil, to be provided with pure air, to be supplied with pure water, and to enjoy the blessing of sunlight. On the other hand, many of our social difficulties arise from there having been a practical absence in each community of

adequate appreciation of the necessity of training the children to become useful members of the community.

Our rapidly increasing population—an increase intensified by our sanitary progress—keeps prominently before us the great social problem of pauperism, and of sanitation in its widest sense; as well as the question of industrial art.

No doubt if we had to start afresh, as a new nation in a new country, and were told to arrange a village or a town to accommodate a certain number of inhabitants, we could easily adapt it to healthy conditions of life. But to retain those healthy conditions would require the careful training of the youths, as well as the regulation of the habits of life of the older inmates, to prevent the vicious, the intemperate, the dirty, from forming *foci* of physical or moral disease, which would endanger the health and the morals of those in close proximity to them.

We now take some faltering steps to abolish some of the numerous causes which favour outbreaks of preventable disease in the midst of our populations. We have made laws to prevent the traffickers in food or drink from selling articles debased or poisonous. We have made it the duty of the authorities to see that water is pure, and to some extent to keep the air free from contamination. But when the wage-earning class of the community awakens to its real interests, it will require that those who traffic in houses, as much as those who deal in food, shall supply them in a healthy condition, and it will insist on the removal from its midst of *foci* of moral as well as of physical refuse.

The question, however, is not how to lay out a new town, but how to make existing cities and their populations such as a nation should be content to possess.

These questions have always been prominent in the discussions of the Society of Arts, because one of its principal objects is the application of the arts to the purposes of life; and the records of the Society show that fruitful discussions within its walls, upon many of the principal questions of social interest, have frequently preceded the legislation which has ensued; and that the Society of Arts, both directly, as well as through the efforts of some of its most eminent members, has been an active worker in the field of social improvement.

For instance, the Society of Arts, and many of its members, have long taken a prominent interest in the spread of education. And amongst those of its members who contributed most largely to the education of the people, we must not omit to mention Rowland Hill, the originator and worker out of that marvellous engine of education, the penny post, and Milner Gibson, the persistent opponent of the tax on paper.

If we look for the earliest and most striking feature of educational progress after the Queen ascended the throne, most will, I think, agree upon the penny post. Those who remember the old post will realise how largely the penny post has acted as an educational stimulus to the nation. It is a matter of pride to the Society that their organisation was used to a large extent to promote the penny postage agitation; and you will see in the life of our former eminent member, Sir Henry Cole, that, as a young man, he was employed by Sir Rowland Hill as an active worker in the propagation of his views. Most of the subsequent important postal improvements have received impetus from discussion in this Society, such as the Parcel Post, the purchase of the telegraphs, the reduction in the price of telegrams, as well as the International Postal Union. The Society may, however, regret that its efforts have not yet succeeded in obtaining an ocean penny postage between this country and her colonial possessions.

For more than thirty years the Society of Arts has made the subject of education a part of its standing work. In 1856 it set on foot examinations in connection with mechanics' institutes and other educational societies in all parts of the country. Its methods were subsequently followed by the Science and Art Department and by the Universities. It made arrangements for technological examinations in 1873, and in 1875 the Society, in remodelling its educational schemes so as to cover ground directly within the objects of the Society, adopted a syllabus of examinations especially suited to those intended to occupy positions in commerce, and awarded certificates in commercial knowledge. The Society of Arts was thus the forerunner of the efforts which have been made to promote technical education, and its efforts were followed in 1877 by the City companies, who then took measures to establish a College of Technical Science, which has developed into that admirably conducted establishment, the City and Guilds of London Institute, which owes so much of its excellence to our former Chairman of Council, Sir

Frederick Bramwell, and to Mr. Owen Roberts, a Vice-President of the Society.

It has been long contended within these walls that the elementary education now given is not entirely satisfactory, as failing to create a supply of boys fitted to take up at once the practical business of life. Our members, Mr. Edwin Chadwick and Dr. Richardson, have long advocated the half-time system in elementary schools, the latter on the ground that the receptivity of the brain of a child is so limited that it is useless to keep him at any form of book learning for more than two or three hours a day, because a child would learn as much in three hours given to book learning as he does in six hours, and that if the other three hours were devoted to some form of manual training a more useful man would result. The object of such technical training is to develop in the best way the intelligence of those of all classes upon whom our industries depend. Hence this sort of training in elementary schools could not be of a uniform character throughout the country; it ought to have some reference to the wants of employers of labour in the district, so that the boys on leaving school may be prepared for their future occupations.

In Scotland there is an Act coming into force, passed last Session, which will enable School Boards to provide technical schools, to supply the necessary apparatus, tools and materials; but in England the question is still in abeyance.

It is, however, satisfactory to know that the City and Guilds of London Institute is now co-operating with the School Board of London in the experimental trial of technical training, combined with the ordinary elementary education, in six of the metropolitan schools. The proposal is to teach carpentry. Arrangements are made for teaching thirty boys at a time. It is intended to give half an hour from the school time and an hour from time out of school, or one-and-a-half hours a day. Three sets of thirty boys would be taught in the week; thus, one set would have lessons on Monday and Thursday, the second on Tuesday and Friday, and the third on Wednesday and Saturday—that is to say, ninety boys in all in each school. It is understood that there is no deficiency of boys desirous to learn. Moreover, as an evidence of the interest which the teachers take in the movement, eighty teachers have gone through a course of training in the Central Institution of the City Guilds in Exhibition-road, and another batch are now coming forward so as to be qualified for assisting in teaching carpentry.

In connection with this subject, you are aware that we have now a very strong Committee on Applied Art, and that, as an incentive to technical progress in art workmanship, the Society has proposed to renew their exhibition of articles made by working men in various artistic industries, which they had discontinued in 1871, in consequence of the series of International Exhibitions commenced at South Kensington in that year. This exhibition will be opened next month in this house, and the Council have reason to hope that it will prove a very interesting exhibition.

It is, however, obvious that the more you develop the preliminary training in boys, the more you fulfil that important function of a school, of teaching the boy how to learn; so that if real profit is to be derived from this increased education, you must perfect the means for further training after the Board school has been left, by evening schools, by secondary schools, and by scholarships. Probably the technical education question is now in a fair way of being solved. But in the branch of commercial training which the Society of Arts has endeavoured for some years to promote, that progress has not yet been made, nor that success achieved, which their efforts might have reasonably led the Society to expect.

It would seem as if our examinations do not touch the class which would most benefit by opportunities for commercial training. Of the want of more systematic commercial training there can be little doubt. Improvements in the means of production will not alleviate commercial depression, unless markets are found for the cheapened products.

The valuable consular reports which are now periodically published show unmistakably that we lose trade, not always because we cannot manufacture as well as our competitors, but often for want of knowledge of the places where markets for our goods may be found, and of the requirements of the markets, which it should be our business to satisfy. This knowledge is supplied to merchants abroad by well-educated agents, skilled in business habits, conversant with foreign languages, and familiar with the physical, social, political, and commercial circumstances of different parts of the world; and this knowledge, it is contended, is afforded by the system of special training adopted in Germany and in other countries, which give men of commerce in these countries an advantage over those at home. Moreover, foreign clerks

are employed largely by mercantile firms in London, to the exclusion of our own countrymen. Many of our own young men are thereby displaced; and these foreign clerks, when they return to their own country, utilise, as competitors in trade, their knowledge and experience here acquired.

You may perhaps ask what is meant by commercial training. You will have, in the course of a few weeks, what I am sure will be an admirable paper on this subject by Sir P. Magnus. Meanwhile I will endeavour briefly to summarise some of the chief requirements of a commercial training. In addition to the elements of a good English education, the most important consideration is that of foreign languages, which must be taught especially in relation to the commercial expressions used. Next will come instruction in commercial geography; but competent teachers of this may be said as yet scarcely to exist. Then comes the question of commercial museums, which should be found in all higher elementary and modern secondary schools.

In the higher elementary schools book-keeping should be taught as a branch of commercial arithmetic, and in these and higher schools instruction should be given in the principles of political economy. Evening classes should afford opportunities for practice in speaking and writing foreign languages, and should supply good instruction in commercial arithmetic, book-keeping, shorthand, and commercial geography.

I have already told you that the examinations for the Society of Arts' certificates have long included many of these as detached subjects. What is now required is that that which we have endeavoured, by means of our own syllabus, to bring to the notice of the public as desirable, should, like other improvements which we have been the first to foster, be now systematically taken out of our hands and treated as a national question.

In the other division of the question of social improvement to which I would desire to call your attention, namely, what may be termed sanitation, the Society of Arts has for many years taken a prominent position. Some twelve or fourteen years ago it organised conferences, at which all the important towns in the kingdom were represented, upon the important questions of removal of refuse, drainage, and water supply.

These discussions cleared the ground for the important sanitary legislation of 1875 and subsequent years; and discussions on sanitary subjects have been continued every year upon numerous valuable papers, culminating in the admirable paper on "The Distribution of Micro-Organisms in the Atmosphere," given to us by Dr. Percy Frankland in the course of last year.

In regard to purity of air, our former chairman of Council, Sir W. Siemens, whose early death was a serious loss to the nation, was actively interested in efforts to preserve the purity of the atmosphere in towns by the prevention of smoke. The adulteration of food has been a frequent subject of discussion. But the question of sanitation does not end with drainage and water supply; it involves those further considerations which the works of Edwin Chadwick and John Simon have just lately brought prominently forward.

Amongst the more important of those questions, there still remains for solution the question of the housing of the poor, which lies at the root of many of our social difficulties, and, indeed, the great question of poverty itself.

I have neither the time nor the space in this Address to enter deeply into the question of housing the artisan and labouring classes, nor of suggesting the extent to which the municipality should step in to assist in the solution of the question. The governing body of each town must deal with its special necessities in its own way, but it is bound to see that they are dealt with; and when we look at what has been done in these respects in Edinburgh, in Glasgow, in Manchester, and in other important centres of population, we may well feel how behindhand we are in the metropolis. But we must remember that we are here unduly weighted in the race for improvement.

The existing laws would do much if properly enforced, but London is a federation of parishes, and except for certain purposes has no unified administration. In some cases, parishes are poor; and in other cases personal interests of members of Vestries may militate against enforcing the law; and all past experience seems to show that until London has been provided with a municipal government, the social improvements which other towns are perfecting must lag behind.

The Metropolitan Board of Works has no doubt done much by clearing away insanitary dwellings; but much remains to be done. And if we are to prevent the evils, which this generation is obliged to pay so much money to remove, from being repeated in the future restrictions must be imposed on the erection

of new buildings; ground not yet built on in towns, as well as ground which has been cleared by the removal of these insanitary dwellings, must not be allowed to be crowded with buildings. No land owner should be permitted to erect houses on a town site unless they are so arranged as to have a due circulation of air front and back, and a due proportion of sunlight: and the height of buildings in towns should be so regulated that they shall not unduly shut out sunlight from neighbouring houses.

In near relation to the question of improved dwellings for the poorer classes stands the question of the notification of infectious diseases. There are several towns in Great Britain which have obtained powers in local Acts requiring that all cases of infectious diseases shall be immediately notified to the authorities. By this means the authorities in those towns have been enabled materially to check epidemics, partly by prompt measures of isolation, and partly by following up such measures by the removal of insanitary conditions in the dwellings of those who had been attacked.

In the metropolis the Metropolitan Asylums Board has built hospitals for infectious diseases and organised an admirable system of ambulance transport, at a great cost to the ratepayers. There is no compulsory notification of infectious disease; and by law the Asylums Board has entrusted to it the duty of removing and isolating one class of patients only, viz., the infectious sick poor. They possess no power, either of ascertaining the general extent of any epidemic amongst other classes of the community, or of compelling the isolation of the patients of those classes; nor is there any enforced examination of the sanitary condition of premises where outbreaks of disease have occurred.

There is at the present time a serious epidemic of scarlet fever in the metropolis. This epidemic is increasing daily in extent. But many of the cases which come into the hospitals of the Metropolitan Asylums Board have been suffering for some time from the disease, and have during that time undoubtedly been spreading the infection around them among the public, hence the limited degree of isolation afforded by the hospitals of the Metropolitan Asylums Board appears to be of little avail to check the disease. I mention this as a practical instance of the small value of expensive isolation hospitals in the absence of power to compel the notification of all cases of infectious disease. But I am happy to think that a movement is now on foot in London to endeavour to induce the Local Government Board to obtain power from Parliament to enforce the notification of infectious diseases in the metropolis.

When we have done all we reasonably can do to prevent the existence of foul dwellings, and to remove the conditions which lead to preventable disease, sanitarians still have before them the question, which is one of daily increasng importance, of how to cope with poverty.

It was well said by Sir John Simon, many years ago, that "if the wages of any class of the community are below what will purchase indispensable food and wholesome lodging, such labour is masked pauperism, and whatever the employer saves is gained at the expense of other members of the community who contribute to the rates. If the labourer or his wife or child spends a month or two in hospital that some fever infection may work itself out, or that the loss of an eye or a limb may be averted by better food, or if he gets aid from his Board of Guardians in preventable illness, it is the public that pays the arrears of wage that should have hindered this suffering and sorrow."

The problem of how to find means of employment for our rapidly increasing population demands the serious attention of statesmen more than any other social problem at the present time. Whilst we may do much by well directed efforts to raise the character of the labouring poor, and to develop, by wise legislation, new resources, and open out new channels of employment for the people, there will still remain a residuum, which, as Miss Beatrice Potter tells us in her interesting article on dock labourers, is influenced by no desire of bettering itself, the members of which will only do as much work as will enable them to get sufficient beer and tobacco, and whom no large employer can advantageously employ directly; the only way in which work can be obtained from such labourers is by sub-contractors, who have a personal interest in their hire, and are thus somewhat in the position of slave-drivers, and they contrive to make this class do a modicum of work.

This is a class little separated from savages, and rejected by unions of respectable workmen, and we must not be surprised if, at no distant future, the self-respecting artisan and labourer should demand that some restraining

action should be taken in respect of this class.

I might mention many other of our social problems at home in which the Society of Arts has taken action, but I am desirous of drawing your attention to another important sanitary question connected with one of our Sections, a question of paramount interest to this country, and which a Society claiming in its title the promotion of commerce cannot disregard. The section I allude to is our Indian Section, the question I would speak of is that of quarantine. I had the advantage of hearing much discussion on that subject at the International Hygienic Congress at Vienna, a congress at which all leading European sanitarians were assembled, and a congress at which the principal European Governments, except that of England, were represented. Without arriving at any conclusion as to the extent to which cholera contagion might be conveyed, the discussions at any rate showed the universally prevalent feeling to be that quarantine was ineffectual to stop the march of cholera, but that its progress was determined entirely by the insanitary conditions it meets on its way. But the remark was made—"You English have, by your sanitary improvements, prevented cholera from gaining a foothold in England; why do you not attack it in its birthplace, and prevent it from springing into life in India? If your Indian ports were not affected with cholera, quarantine against India would fall of itself." We may well ask ourselves why have we done so little for the sanitary improvement of Indian populations. It has not been for want of knowledge.

In 1860, a Royal Commission, at the head of which was the present Lord Derby, reported on the sanitary defects of both the military and civil populations in India. Those affecting the military have been largely removed; those affecting the civil population are comparatively untouched. The Commission recommended the establishment in India of a body analogous to the old Board of Health or the present Local Government Board, which should have power to inquire, to suggest remedies, and to make advances to local communities for the removal of sanitary defects, on the security of rates, such advances to be repaid by instalments. This was not done, but sanitary commissioners were appointed, who collected statistics, inspected, and occasionally advised. They have collected in twenty-five years a vast mass of information; this information all points one way. Where there is damp, dirt, and bad water, cholera, as well as the still more deadly fevers, thrive; where these favouring conditions are wanting, cholera and many other preventable diseases do not exist.

In Calcutta there are sections of the town carefully looked after and supplied with good water, in which there is no cholera; in other sections of the town there is no water except from foul tanks or shallow wells in a polluted soil; refuse is not properly removed. In these places cholera is rife. In some districts of the country the Government officers, by promoting irrigation and the cultivation of certain crops close round villages, have encouraged fever and disease.

It is not too much to say that a very large proportion of the Indian population suffer from disease, and is thus incapacitated from work, and thereby the productiveness and consequent revenue of India is seriously damaged. It is the interest quite as much as it is the duty of England to remove these preventable sources of ill health in India, and it is a very fair reproach that continental nations address to England—Why do you still permit cholera to find such favourable preventable conditions for its development in a country administered directly by you?

This is a subject which the Indian Section of the Society of Arts may well take up, and I am glad to have learned that a valuable contribution to this question will probably, at an early date, be presented to the Section for discussion, by Mr. Justice Cunningham, who, when in India, in addition to his judicial functions, occupied the position of President of the Health Society of Calcutta.

The Society of Arts has always looked upon it as its duty to promote discussions, through the agency of its Foreign and Colonial Section, upon commercial questions connected with our Colonies. More than a hundred years ago it endeavoured to foster trade with our Colonies, by establishing a small museum of specimens of various colonial products; this was, however, gradually discontinued.

Last year the Society assisted the executive council of the Indian and Colonial Exhibition in many ways, and notably in arranging for and obtaining from competent persons, the very valuable series of reports on the principal industrial products of the various Colonies—a work which was admirably edited by our able secretary, Mr. Trueman Wood.

The Society of Arts was relieved to a great

extent of the Colonial part of its work, by the formation, some years ago, of the Colonial Institute, which was created for the exclusive consideration of questions affecting the colonial interests of the Empire, and has been most useful in pushing forward the question of how best to cement the union of the Colonies with the mother country. That question has now received a great additional impetus from the action of our President, H.R.H. the Prince of Wales. He has inaugurated the Imperial Institute, which, if it realizes the aspirations of its founder, will bring the people of this country into closer relations with our colonial brethren, not only by giving to all classes in this country the opportunity of becoming practically conversant with the products, the resources, and the conditions of life in the several Colonies, but by creating as it were a colonial exchange, that is, affording to our colonial brethren a place where their respective wants will be authoritatively set before the people of this country and of the other Colonies; and especially by drawing into one focus, and thus largely intensifying the scattered efforts which are now being made in various dependencies to advance scientific and practical training; it will thus promote, in a consistent manner, the social progress of the whole of the huge federation of States which constitutes the British Empire. In the fact that the Organising Secretary of the Institute is Sir Frederick Abel, my immediate predecessor in the chair, we have, I am convinced, a further guarantee that the efforts of the Institute will be wisely directed, and its influence usefully employed.

As members of a Society which has devoted a large share of its attention—and that not only in recent years, but since its formation 130 years ago—to subjects of interest connected with our Colonies, it behoves us to consider in what way the interests and objects of the Society of Arts will be affected by the creation of the Imperial Institute.

The functions of the Imperial Institute, vast and important as they are, can in no way detract from, but I believe will materially add to, the opportunities for usefulness for which the Society of Arts has hitherto formed a field in connection with colonial questions. The Institute will bring our colonial brethren in large numbers to our doors; and just as we have now attached to us numerous affiliated societies in various towns in England, so do I hope soon to see societies affiliated to the Society of Arts in all the principal cities of our Empire; and, independently of any question of respect for our President, I believe that the members of the Society have acted wisely in coming forward among the scientific societies of Great Britain, as the largest contributor amongst those bodies to the funds of the Institute.

I have endeavoured in this brief Address to show you that whilst the Society of Arts has already achieved much towards advancing the material and social progress of the nation, there yet remain questions of enormous magnitude, in the discussion and promotion of which the Society of Arts still has a vast field for usefulness. The material and social progress which the nation has achieved in this first fifty years of the Queen's reign is but an instalment of what all must hope for who desire to see a happy and contented people.

The most advanced thinkers and the best educated persons in the nation are at the present time devoting their whole energies to the consideration of these various social problems. It is from no lack of desire in the leading spirits of the nation that their solution remains in abeyance. It is because from their intricacy, each movement in advance must be well considered, lest a false step should throw us into a worse confusion.

That the Society of Arts has had a considerable power of usefulness may in a great degree be attributed to its good fortune in having had for its Presidents during so many years—first, H.R.H. the Prince Consort, who gave a vast impetus to everything which was advantageous to the social progress of the nation, and now H.R.H. the Prince of Wales, of whom it is sufficient to say that whilst he treads in the footsteps of his father and of the Queen, his name will ever stand prominent in the annals of the nation for his unwearied efforts to cement into a magnificent federation the various portions of the British Empire.

SIR HENRY DOULTON proposed a hearty vote of thanks to Sir Douglas Galton for his admirable address. He had treated of a variety of subjects, had taken his auditors all round the world, and had ended with what had been the dream of many Englishmen, but which now bid fair to be realised, the closer union of the empire. This address showed how admirably Sir Douglas Galton was fitted for the office of Chairman of the Council. He had often thought how fortunate the Society had been of late years in this respect, for considering the vast variety of subjects it dealt with, they needed men of great information, and it seemed to him they had had a

series of Admirable Crichtons. He could not but be struck, when listening to a *resumé* of the Society's work, by the fact of how much it had done to further the physical and moral progress of the people, and he was much pleased by the allusion to those three eminent men who, by their eloquence, persistence, and courage, had so much advanced sanitary science and the arts. But the Chairman had not only told them what had been done in the past, but indicated what had to be done in the future, and he thought the Society could not have a better guide and leader for the ensuing year.

Sir FRANCIS DILLON BELL, K.C.M.G., in seconding the motion, begged to congratulate Sir Douglas Galton also on the distinction which the Queen had graciously conferred upon him during the past year. The subjects he had referred to touched the very foundations of the present difficulties of society, not only in this country but in all parts of Europe. There was no doubt that the increase of population, and the pressure which was every day becoming stronger on the means of subsistence, had made the science and art of government extremely difficult, and the problem for statesmen, leaders in commerce and trade, and the chiefs in the science of the day, was to devise some means by which the principles which they were in the habit of calling Socialism could be reached without disturbing the foundations of society. There was nothing at the present day of so much importance as to see that they did not inadequately appreciate the enormous difficulties which existed in the distinctions dividing the people of the country. The questions, particularly of the housing of the poor and of sanitation, in which the Chairman was so distinguished an expert, were the leading features in any social improvement, but in every other branch of the moral and physical improvement of the people, the Society could perform considerable service to the State; and it was very gratifying, therefore, to see the direction of its affairs in such good hands. He could not conclude without saying a word upon the Imperial Institute and the functions it was destined to fulfil. Having regard to what he had already said about the increase of population, it was of the highest importance that more attention should be paid to those fields for the development of the commerce and trade of the country which existed in the Colonial Empire. It was the great merit of the Prince of Wales that he had directed attention more strongly to that subject than it had been before, and in the Institute he had founded, he believed they would see a development which would enormously aid the wealth and prosperity of this country as well as of its colonial possessions. Every one who visited the Colonial and Indian Exhibition last year, must have been struck by the enormous wealth of every kind which the English possessions across the sea were capable of yielding, and which furnished a means of extending on a wider scale the commerce and trade of this country. No greater service to the country had ever been performed by the Prince of Wales than that of initiating the Imperial Institute and it would always be a matter of pride to the Society of Arts that it had been one of the largest contributors to the scheme.

The motion having been carried unanimously,

The CHAIRMAN thanked the members for their kind appreciation of his services; and then presented the Society's Silver Medals to the following persons for papers read by them before the Society during last Session:—

To A. GORDON SALAMON, for his paper on "Purity of Beer."

To WILLIAM P. MARSHALL, for his paper on "Railway Brakes."

To DR. PERCY FRANKLAND, for his paper on "The Living Organisms of the Air: the Effect of Place and Climate on their prevalence."

To A. RECKENZAUN, for his paper on "Electric Locomotion."

To MRS. ERNEST HART, for her paper on "Cottage Industries in Ireland."

To T. ARMSTRONG, for his paper on "The Present Condition of Applied Art in England, and the Education of the Art Workman."

To J. STARKIE GARDNER, for his paper on "Wrought Ironwork."

To WALTER CRANE, for his paper on "The Importance of Applied Arts, and their Relation to Common Life."

To ALLAN RANSOME, for his paper on "Colonial Woods."

To RICHARD BANNISTER, for his paper on "Colonial Wines."

To DR. GEORGE WATT, C.I.E., for his paper on "The Economical Condition of India."

To HOLT S. HALLETT, for his paper on "New Markets and Extension of Railways in India and Burmah."

Miscellaneous.

INTERNATIONAL RAILWAY CONGRESS, MILAN.

The following conclusions, formulated from the proceedings of the second International Railway Congress, recently held at Milan, are appended to the questions arranged for its considerations by the Permanent International Commission. With regard to the special question, No. 1 on the programme, the rules governing the composition of international congresses were slightly modified, Art. 2 reading as

follows:—"The Association consists of the adhering Governments or Administrations which work or have the concessions of railways of public utility."

SECTION I.—PERMANENT WAY AND WORKS.

2. *Metal sleepers.*—What conclusions may be drawn, both from an economical and a technical point of view, from recent results obtained with metal sleepers?—Metal sleepers are generally to be recommended, though there has not been a sufficiently long experience to justify a definite conclusion on the subject.

3. *Metal bridges.*—What are the results obtained with steel in the construction of bridges, and how far may the use of this metal be extended in such structures?—Mild steel is preferable to iron, as being stronger and cheaper; but great care must be exercised in its selection, especially in bridges of large span or subject to great variations of temperature.

4. *Maintenance of way.*—What is the best system of maintaining permanent way as regards safety and economy?—The maintenance should on no account be let to a contractor, but may be performed piecework with advantage.

5. *Snow.*—What precautions should be taken to prevent the line from being obstructed by snow, and what are the most efficacious and economical systems for clearing the line of snow?—Snow is so variable a quantity in different countries that it is useless to lay down any general rule on the subject.

6. *Severely-tried lines.*—What influence do the conditions of laying lines of heavy traffic exert on the expense of maintenance both of permanent way and of rolling stock?—Without giving a definite answer to this question, the Section affirmed that good ballast, frequently renewed, larger sleepers and stronger fish-plates than those hitherto used, are to be recommended, with minute and constant inspection.

SECTION II.—TRACTION AND ROLLING STOCK.

7. *Engine-drivers.*—Service of engine-drivers, with respect to a better utilisation of engines and a just distribution of work, taking into account the different seasons, the complexity of service, and the hygienic conditions of the districts traversed.—Instead of each driver having a particular engine, a gang of drivers should be attached to a set of engines, thus saving much current expense. It is a popular error to suppose the driver's lot is a hard one.

8. *Passenger stock.*—The conditions of constructing passenger carriages, as regards balanced wheels, bearing springs, and reduction of dead weight.—Carriage wheels should be perfectly balanced, a double system of bearing springs is to be preferred, and an elastic substance should be interposed between the body and under frame; dead weight per passenger should be reduced as far as possible, an extra charge being made for additional room afforded.

9*a*. *Locomotives.*—What are the best conditions for constructing locomotives as regards the influence of suspension on the expense of maintenance; the application of the compound principle; the metal to be used for boilers, tubes, stays, &c.?—While steel proper is not suitable for boilers, a cast homogeneous metal (mild steel) is to be recommended, with copper for fire-boxes, the remainder of the question being adjourned to next congress.

9*b*. *Locomotives.*—What are the best conditions for constructing locomotives as regards the use of a jet of steam or water for increasing the adhesion of the wheels on the rails; and how far should repairs to locomotives be executed in running sheds?—Sand should be superseded by a jet of water or exhaust steam; and it must depend on each individual case, the amount of repair needed and the capabilities of the running sheds, whether locomotives be repaired in them or be sent to the works.

10. *Lubrication.*—What is the best lubricant and the best form of axle-box?—A mixture of vegetable and mineral oil is to be recommended, with due regard to the influence of climate, and white metal for axle bearings.

11. *Premiums.*—What is the best system of premiums?—Drivers should be paid fixed and sufficiently remunerative wages, with premiums for economy, provided they do not interfere with safety and regularity.

12. *Brakes.*—What conclusions are to be drawn, from a technical and economical point of view, from recent results obtained by the use of continuous brakes, automatic or otherwise, for goods and passenger trains?—Continuous brakes are impossible on international goods trains, so long as the rolling stock of the various countries differs so widely; and improved brake connections are required for passenger trains.

13. *Lighting and Warming.*—What results are obtained (*a*) by new methods of lighting trains (petroleum, electricity), and (*b*) by the new methods of warming them?—(*a*.) Enriched gas is preferable to naphthaline; and, on account of the technical difficulties attending the electrical lighting of trains, this part of the question is left over to next congress. (*b*.) Movable foot-warmers have hitherto given the best results; but the question of warming is not yet satisfactorily settled.

SECTION III.—WORKING.

14. *Tickets.*—What are the most effectual measures for checking passengers' tickets?—Tickets should be examined and collected in the trains, instead of at the exits from stations, the collectors being themselves under supervision. This was the subject of a report by the late Mr. J. Grierson, general manager of the Great Western Railway, detailing the practice on this line.

15. *Passenger trains.*—What are the most favourable conditions for organising passenger trains on main lines (rational division of trains into categories,

and number of classes in each) ?—The Section presented a report, giving much information, but invited further particulars, and adjourned the conclusions to next congress.

16. *Goods traffic.*—(*a.*) What are the most favourable conditions for organising goods traffic in full loads ? (*b.*) What are the measures best calculated to lessen the expense of carrying incomplete loads ?—This question formed the subject of a report by M. P. Niels, traffic inspector on the Belgian State railways, and by the administration of the French Eastern Railway; but no conclusion was arrived at.

17. *Lines with slight traffic.*—How may these lines be simplified so as to be worked economically ? Would it be possible to farm the service of small stations, and if so, what precautions should be taken to ensure trustworthy service ?—A reduced speed, the suppression of fences, which often favour rather than avert accidents, and of watchmen at level crossings, the adoption of composite carriages with through passages and only two classes, and simplification of stations, signals, and working generally were recommended, as well as the sub-letting of unimportant branches.

18. *Shunting.*—What are the best methods of shunting so as to ensure safety and economy ?—Further particulars invited and conclusions deferred till next congress.

19. *Lighting of stations.*—What results have been obtained by gas and electricity ?—Electric lighting is preferable to that by gas; but further information and experience are required.

Section IV.—Questions of General Interest.

20. *Personnel.*—The organisation, recruiting, and training of railway servants, both clerks and workmen; and the employment of women.—Special schools should be established for training railway servants, who should be chosen as much as possible from the families of those already so employed. Women evince great steadiness and sense of duty in railway work; and their deficiency of physical power could be met by such appliances as the hydraulic apparatus used on the Mediterranean Railway for working points and signals.

21. *Remuneration.*—What is the best manner in which to remunerate *employés*, and give them an interest in economical working ?—Higher wages should be paid to the lower grades of railway servants, with a simplification of their work, which should be lightened by mechanical means.

22. *Provident institutions.* — Statistics to be collected for next congress.

23. *Rates and taxes.*—How far do special and general taxes affect railways in the different countries; and what, in the interest of railway development, are the remissions of tax to be sought after, especially as regards secondary lines ?—All taxing of the carriage of goods should be abolished, especially for short distances.

24. *International relations.*—Means for developing international relations among railway administrations.—This matter, the subject of a report by Cav. Ing. Fadda, was referred to the Permanent International Committee.

25. *Technical information.*—This matter formed the subject of a long and detailed report by M. A. Hodeige, engineer on the Belgian State Railways, which was endorsed by the congress.

Section V.—Questions specially affecting Secondary Lines.

26. *General arrangements.*—What are the general arrangements of permanent way, stations, signals, rolling stock, &c., most suitable for working secondary lines ?—Single line railways of very narrow gauge and great simplicity were recommended, with ten-ton carriages having longitudinal passage, and the suppression of luggage van between the engine and first carriage.

27. *Traction.*—What are the best methods of traction on secondary lines ?—Except so far as the conclusions of Question 26 apply, no opinion was expressed on this subject. A report was, however, drawn up by M. G. Michelet, administrator of the Compagnie Générale Belge des Chemins de Fer Sécondaires, giving an account of the modes of trcction employed on several secondary lines, with the cost of working.

28. *Brakes.*—What brakes should be used, when the line follows a road, for ensuing safety with an increase of speed ?—Continuous brakes are unnecessary for secondary lines, as hand-brakes are found sufficient.

29. *Transhipment.*—What are the most practical means for facilitating the exchange of passengers and goods between main and secondary lines, as regards (*a*) the exchange of passengers and transhipment of goods, and (*b*) the regulation of these relations ?—Transhipment is the great disadvantage under which secondary railways labour; but (*a*) the secondary should be brought so near to the main line that the wagons almost touch each other; while (*b*), for transferring passengers, it is sufficient that the platform of the secondary line be brought as near as practicable to that of the main railway.

30. *Feeders of traffic.*—(*a.*) Secondary lines being essentially feeders, how should junctions between railways of different gauge be classed ?—As the rolling stock of one cannot run on the other, the stations cannot be classed as common. (*b.*) In what cases should there be a community of service, and when separate services ?—If the gauge is the same there can be, and indeed is frequently, a common service. (*c.*) In the case of separate services, is there not reason to assimilate them to those of private branches ?—No; the conditions are not the same.

31. *Uniformity of rolling stock on secondary lines.* — Should not some agreement be arrived at for adopting uniformity, especially in draw-gear and buffers, with a view to facilitate the interchange

of rolling stock?—As secondary lines are established for local purposes, they should be arranged to meet the wants of each particular locality; and any movement for combining them into a system would inevitably be regarded by railway administrators as evidence of competition, which it is most desirable to avoid. Section V. expressed the hope that secondary lines be regarded as the auxiliaries and not the competitors of railways, and invited further information.

32. *Tickets on secondary lines.*—What are the best means for *controlling* (checking) passengers, and the best system of tickets for the purpose?—These questions formed the subject of a report by M. A. Tellier, of the Société Nationale des Chemins de Fer vicinaux de Belgique, which was generally approved by the congress; but it was recommended that experience be waited for of the best methods now in use or under consideration.

The president of the Congress was Commendatore Professore Brioschi, senator of the Kingdom of Italy, and director of the Milan Technical Institute; the general secretary, M. Auguste De Laveleye, director of the *Moniteur des Intérêts Matériels*, Brussels; and the secretary, M. Eugène Kesteloot, chief of division at the Department of Railways, Posts, and Telegraphs for the Kingdom of Belgium, the two gentlemen last named filling the same offices in the permanent International Commission.

The British Government was represented at the Congress by Major-General Hutchinson, chief railway inspector to the Board of Trade; and the railway department of the Indian Government by Colonel C. H. Luard, R.E.; the Great Western Company by its late general manager, Mr. James Grierson; the Great Eastern Company by Sir Henry Tyler, M.P., director, and Mr. John Wilson, engineer-in-chief; the Great Northern Company by Sir Andrew Fairbairn, director; and the North Eastern Company by Mr. John Cleghorn, director, and Mr. C. N. Wilkinson, secretary. M. Perk, of the Russian Government; Señor Pincheiro, of the Brazil Government; Herr Jeitteles, of the (Austrian) North Emperor Ferdinand Railway; and Herr Dittles, of the St. Gothard Railway, were added to the Permanent International Commission; and the next congress was fixed for 1889, in Paris, M. Léon Say promising a hearty welcome.

Notes on Books.

LUNACY IN MANY LANDS. By G. A. Tucker. Sydney, 1887. 8vo.

Dr. Tucker, who has had experience of many years as superintendent of lunatic asylums in Melbourne and Sydney, undertook in 1882 to visit the chief asylums of the world. He first visited Victoria, South Australia, Tasmania, New Zealand, and Honolulu, then crossed the Pacific to San Francisco, and visited the United States and Canada. He subsequently travelled over most of the countries of Europe, visited Tunis and Algiers, and completed his labours by visiting the chief asylums of Great Britain and Ireland. During these travels Dr. Tucker visited and inspected over four hundred asylums, and communicated with more than a hundred others, chiefly small establishments. He altogether travelled over about 140,000 miles. The results of the author's researches are recorded in this large volume of 1,564 pages, and arranged under the various countries, full particulars being given of each of the asylums visited.

HANDBOOK OF MODERN CHEMISTRY, Inorganic and Organic, for the use of Students. By Charles Meymott Tidy, M.B., F.L.S. Second edition, revised and enlarged. London: Smith, Elder, & Co. 1887. 8vo.

The first edition of this book was published in 1878, and Dr. Tidy has now, besides revising the whole work in accordance with the growth of the science, added rather more than one hundred pages of new matter. The information is clearly set out, and a full index completes the volume. The appendix contains a series of tables.

EXPERIMENTAL CHEMISTRY FOR JUNIOR STUDENTS. By J. Emerson Reynolds, M.D., F.R.S. Part 4. London: Longmans, Green & Co. 1887. 12mo.

This volume completes Dr. Reynolds's work, and is devoted to the chemistry of carbon compounds or organic chemistry. The subjects of the previous parts are as follows: Part 1, Introductory; Part 2, Non-Metals; and Part 3, Metals. There is an appendix to the present part on "Ultimate Organic Analysis."

General Notes.

FRUIT FROM THE COLONIES.—The November Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, is the first of a series of papers in which information will be given as to the capabilities of our colonies to grow and export fruit. The authorities of Kew have little doubt that, if proper arrangements were made for packing and shipping, large quantities of fruit might be exported from Cape Colony, Natal, the Australian colonies, and New Zealand. It is thought that much of this, arriving in England during the winter and early spring months, would be readily bought to supply the wants of the community, and that the prices paid for such

fruit as an article of luxury would be sufficiently high to cover the cost of bringing it from the southern hemisphere.

TECHNICAL INSTRUCTION IN FRANCE AND BELGIUM.—The Union des Ouvriers Mécaniciens du Department de la Seine has arranged for a course of instruction, free, including books, &c., to be given this winter in mechanics, mechanical drawing, and screw-cutting, including conic sections. A clock and watchmaking class was opened on 1st September, at the Ecole Industrielle, Brussels; and in the short time that has elapsed the sixteen pupils have made great proficiency. The first clock finished is to be presented to the King of the Belgians, owing to whose initiation the class was started, and four are to be shown at the International Exhibition to be held at Brussels next year; and the others placed in the museum attached to the school; but none are to be sold, so as not to interfere with trade interests. The class was organised by the Comité des Ecoles Professionnelles, and the instructor is M. Baron, professor at the Paris school of clock-making. The clock and watch trade does not, properly speaking, exist in Belgium, as watchmakers have to employ foreign workmen, chiefly Swiss and Germans.

COLOUR BLINDNESS IN SEAMEN.—A report by the Assistant-Secretary of the Marine Department to the Secretary of the Board of Trade, on the tests for colour blindness used in examining candidates for masters' and mates' certificates of competency, and others in the British mercantile marine, has been issued as a Parliamentary paper. The colour test system was introduced in the mercantile marine in 1877. The testing methods adopted are two—a kerosene lantern containing red, pink, green, yellow, neutral, and blue slides for artificial light; and white, black, red, pink, green, drab, blue, and yellow cards for daylight. Any person serving or about to serve in the marine may be examined in colours on payment of 1s. fee. The advantages of the system to seamen intending to take certificates of competency as masters or mates are pointed out. The forms of examination in such cases may either be compulsory, with a view of obtaining an officers' certificate, or voluntary, in colours only. In 1886-7 there were 4,124 candidates examined in the compulsory class, as against 4,215 in the previous year. The number rejected for imperfect colour sense was 25, as compared with 45 in 1885-6. In the voluntary class the number examined was 415, as compared with 294 in 1885-6, the number rejected being 26, as against 18 the previous year. It is stated that, speaking generally, one out of 200 candidates for officers' certificates fails. As to the nature of the mistakes made by the rejected candidates, it is shown that in the daylight test with cards ten persons describe black as green, 17 red as green, 44 pink as green, and 51 drab as green. In the coloured glasses test 107 out of 189 described standard green as red, and 24 standard red as green.

STEAM TRICYCLE.—*La Nature* has lately given an illustrated account of a steam tricycle designed by Messrs. Roger de Montais and L'Héritier, which will travel nine to eleven miles per hour with one person, and eight to ten with two. In front is a small petroleum-heated boiler, which is said to give off no smoke, smell, nor unpleasant heat, and a petroleum reservoir is placed under the seat, holding $2\frac{1}{4}$ gallons, said to be enough to last ten hours. A water reservoir, which holds $7\frac{1}{2}$ gallons, is mounted, carrying a supply for $2\frac{1}{2}$ hours. Exhaust steam passes into one part of the tank from a small vertical engine.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 21...Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Admiral Selwyn, "The present circumstances of the Patent-laws."
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m.

TUESDAY, Nov. 22...Metropolitan Provident Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., $8\frac{1}{2}$ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Sir Frederick Abel's paper, "Accidents in Mines."
Anthropological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m. Canon Isaac Taylor, "The Primitive Seat of the Aryans."

WEDNESDAY, Nov. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Silvanus P. Thompson, "The Mercurial Air-pump."
Geological, Burlington-house, W., 8 p.m. 1. Mr R. Lydekker, "Note on a New Wealden Iguanodont, and other Dinosaurs." 2. Prof. T. M'Kenny Hughes, "The Cae-Gwyn Cave." 3. Prof. T. M'Kenny Hughes, "Further Observations on the Drifts of North Wales."
Microscopical, King's College, W.C., 8 p.m. Conversazione.

THURSDAY, Nov. 24...Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.
Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m..
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Dr. J. A. Fleming and Mr. E. H. Gimingham, "Some Instruments for the Measurement of Electromotive Force and Electrical Power." 2. Professor W. E. Ayrton and Mr. John Perry, "Portable Voltmeters for Measuring Alternating Potential Differences."

FRIDAY, Nov. 25...Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., $8\frac{1}{2}$ p.m.
Browning, University College, W.C., 8 p.m. Paper by Prof. Barnett.

SATURDAY, Nov. 26...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thomson, "The Analogies of Influence Machines and Dynamos." 2. Mr. H. Tomlinson, "Effect produced on the Thermoelectrical Properties of Iron, when under stress or strain, by raising the temperature to a bright red." 3. Mr. H. G. Madan, "Optical Properties of Phenyl-thiocarbomide."
Botanic, Inner Circle, Regent's-park, N.W., $3\frac{3}{4}$ p.m.

Journal of the Society of Arts.

No. 1,827. Vol. XXXVI.

FRIDAY, NOVEMBER 25, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The Council have to acknowledge the receipt of a donation from Sir Frederick Bramwell of £100 towards the Endowment Fund of the Imperial Institute, sent in response to the announcement in the *Journal* of November 4th, that the Council had consented to receive subscriptions for this purpose.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for October 28th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered was given in the number of the *Journal* for September 16th last, and can be obtained on application to the Secretary.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, Nov. 23rd, 1887; WILLIAM CROOKES, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bridger, Lowther, General Post-office, E.C.
Child, Robert, 62, Hampstead-road, N.W.
Emden, Walter, 36, Southampton-street, Strand, W.C.
Gotz, John R., 19, Buckingham-street, Strand, W.C.
Greenaway, Lieut.-General Thomas, Staffa-lodge, Guildford.
Logan, William George, 11, John-street, Adelphi, W.C.
Scriven, Richard, Castle Ashby, Northampton.
Skilton, Charles Henry, St. Leonard's, Barry-road, East Dulwich, E.C.
Walker, William H., 7, Romola-road, Herne-hill, S.E.

The paper read was—

THE DEVELOPMENT OF THE MERCURIAL AIR-PUMP.

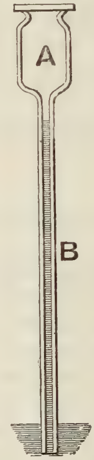
By Professor Silvanus P. Thompson, D.Sc., B.A.

Within the range of the physical sciences there are many subjects of interest to the investigator, some of them of importance in the technical industries, which yet are little known, save to the close student of scientific literature. An idea occurs to some original worker, who makes experiments, records results, draws inferences, and embodies his investigations in a memoir or note in the more or less obscure journal of proceedings of some scientific society, where it remains buried amid a heterogeneous mass of like matter. A few years later another worker, not knowing what has been done, stumbles across a similar idea, constructs his apparatus, makes his experiments and observations, and in turn consigns his work to a similar temporary oblivion. Years after, or it may be centuries, the progress of science in other departments reaches a point where it touches the unremembered work of those who are gone. Were that work available, were even a plain clue to its existence known, it would be at once brought into line and made useful. For want of such a clue it remains buried, and the world has to wait for some other to re-investigate what already was a portion of acquired knowledge; and the useful application to industrial purposes is delayed—perhaps for years. He who will explore the dusty corners of science, will hunt up the hidden treasures, arrange them, co-ordinate them with more recent knowledge, and render access to them easy for the busy workers around him, performs a service which, though it brings no renown, is at least useful.* In such dusty corners of science lie the scattered fragments of the literature of the mercurial air-pump.

All true mercurial air-pumps are, of course, based upon the principle of the barometer; that is to say, in all of them the vacuum is constituted in the manner invented by Torricelli, namely, in an enclosed space above a barometric column. In all of them the object is to render the Torricellian vacuum as perfect as possible. In some of them the object is effected by driving the air upwards out of the barometer head by raising the barometric column; in others, the air is forced downwards by the injection of more mercury into the barometer-head. In others again, the air is pushed up one barometric column and down another. In some recent kinds of mercurial pump, several of these forms are combined. Other pumps again depend on the injection of mercury at high pressure through an orifice. These distinctions will furnish us with a basis for classification. Before attempting this, however, a few general historical notes may be given.

In 1643, Torricelli discovered the possibility of producing a vacuum above the top of a mercury column, by filling with mercury a tube closed at one end and then inverting it into a cup containing mercury. Until 1650—a period of seven years—when the mechanical air-pump was invented by von Guericke, there was no other way of producing a vacuum, and the Florentine Academicians, who made in the interval many experiments on the properties of vacuous space, employed as their pump a Torricellian tube (Fig. 1) enlarged at its upper part into a bulb or reservoir closed at the summit by a cover, luted on with some suitable sort of cement. The apparatus is figured in Daguin's "Traité de Physique," vol. 1, p. 278, (edition of 1855). Writing in 1855, Daguin states that though the employment of the vacuum obtained by the lowering of a mercury column had been perfected by Baader and by Hindenburg, their machines required such a large quantity of mercury that they had been abandoned in favour of the mechanical air-

Fig. 1.



Tube Used by Florentine Academicians for Exhausting.

* The author here desires to express his indebtedness to the many friends who have assisted in collecting this information; also to the valuable paper by Herr E. Bessel-Hagen, referred to in the text. He also desires to refer to a memoir by Professor Hellmann, of Riga, a copy of which he received only after the greater part of this paper was already compiled.

pump. The Torricellian method of exhaustion was pursued however, whenever a very perfect vacuum was required, for example, by Count Rumford,* in his researches upon the propagation of heat. The bulb to be exhausted he sealed to the top of a barometric tube having a constriction near the top; it was then filled with hot recently-boiled mercury and inverted, when the mercury left the bulb vacuous. It was then sealed off before the blow-pipe just as exhausted glow-lamps are sealed off to-day. An arrangement almost identical with that of the Florentine Academicians was suggested as a novelty so late as 1810, by Traill.† In 1845, Edward A. King‡ patented the construction of an incandescent electric lamp, having a carbon pencil situated in the Torricellian vacuum at the upper end of a barometer tube, a further suggestion being made for sealing the exhausted lamp. Amongst still more recent methods of producing in a glow-lamp a Torricellian vacuum without the aid of any specific pump, may be noted that of André,§ who seals the lamp globe to the top of a barometric tube, another short tube opening into the bulb being sealed on above. Mercury is driven from below until it fills the lamp, when the upper tube is temporarily stopped, the mercury being then lowered, creating a vacuum into which the occluded gases are liberated; the mercury is then raised, and these gases expelled through the stopper, and the lamp is sealed at the top; then the mercury is lowered and the lamp is sealed off at the bottom. Swinburne‖ has also tried this method, but has not found it successful. None of these processes of utilising the Torricellian vacuum amounts to the invention of a distinct Torricellian air-pump. Although most of the mercurial air-pumps to be described started from the fundamental notion of producing a barometric vacuum, it seems possible, if not probable, that some, at least, of the various forms had a different origin. Two of the main defects of the ordinary mechanical air-pump, are the faulty packing of the pistons and the unavoidable clearance-space between the piston and the end of its cylinder. It naturally occurred to several experimenters, possibly to many, that both these defects might be obviated by covering the piston with a layer of mercury. Air-pumps thus provided with a mercury

* Rumford. Essays, vol. ii., p. 393. (Edition 1798.)

† Traill. "Nicholson's Journal," xxi., pp. 63 and 161.

‡ King. Specification of Patent, No. 10919, 1845.

§ André. Specification of Patent, No. 4654, 1881. Electric Illumination, vol. i., p. 665.

‖ See *Electrician*, xix., 159, July, 1887.

packing have been described by Kravogl* for exhausting, and by Régnault† and Cailletet for compressing. In the following sketch, however, attention is confined to the barometric species of pump. It will be convenient to classify these machines under the following heads:—

CLASSIFICATION OF MERCURIAL AIR-PUMPS.

I. Those which drive the air up a barometric tube.

II. Those which drive the air down a barometric tube.

III. Those which drive the air up one barometric tube and down another.

IV. Combination pumps.

V. Injection pumps, dependent in their action upon the velocity of efflux of a stream of mercury.

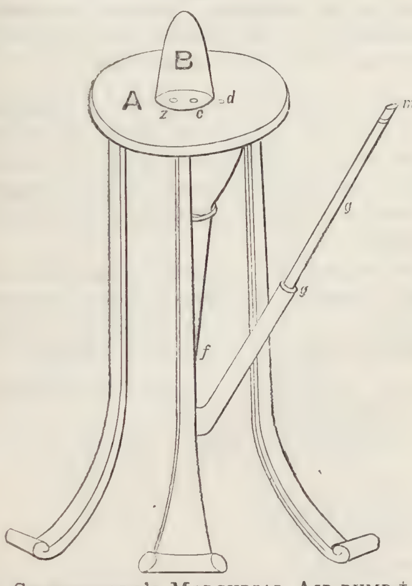
VI. Mechanical mercurial pumps.

Under the first three of these classes there are sub-classes comprising "shortened" pumps.

CLASS I.—UPWARD DRIVING PUMPS.

The oldest of all mercurial air-pumps belongs to the class in which the air is forced upwards above the top of a barometric column. It was

FIG. 2.



SWEDENBORG'S MERCURIAL AIR-PUMP.‡

* Kravogl. "Carl's Repertorium," iii., 362, 1868. See also Deschanel's "Natural Philosophy" (1881), i., 190. Similarly a mercury packing was employed in a water-pump by Haskins, and is described in Desagulier's Course of Experimental Philosophy (1763), vol. ii., p. 491.

† Régnault. "Rélation des Expériences," ii., 553.

‡ Swedenborg. "Miscellanea observata circa res naturales." Lipsiæ. 1722. Fig. 11.

invented by Emanuel Swedenborg, the famous theosophist, and is described in his "Miscellanea,"* published in 1722. The apparatus and a drawing of the machine is given, which is reproduced in Fig. 2. A glass receiver, B, stands upon a plate, A, as in the ordinary mechanical air-pump, and the plate, A, is supported on three legs forming a tripod table. "Beneath this table," to follow Swedenborg's own words, "there is a certain conical vessel, E, of iron, hollow, and accurately fixed on the under side of the table so that it includes two apertures, *c* and *d*, furnished with valves." The valve *c*, opens downwards, the valve *d*, upwards. The lower end of the iron vessel ends in a flexible leather tube, *ff*, to which is adapted a piece of iron tube, *gg*, ending in an open mouth piece, *m*. This iron tube was to be alternately raised and lowered precisely as is done in the modern Geissler or Toepler pump with the mercury vessel. Swedenborg's instructions are precise.

"OPERATIO.—Immitte mercurium vivum per (*m*), illa copia, ut repleat (*f*) (*f*) et aliqualem partem *E*; si dein sursum levas (*g*), tunc mercurius ascendit in *E* usque ad mensulam: si dein demittis idem (*g*) infra altitudinem 28 pollicum, tunc descendit mercurius in *E*, attrahit secum aërem ex recipiente per valvulam (*d*), et sic levando et demittendo, dum omnis aër sit exantlatus. Habeas etiam foramen quoddam in (*z*) sub mensula, quod aperias ope trochleæ, et immittas aërem cum velis."

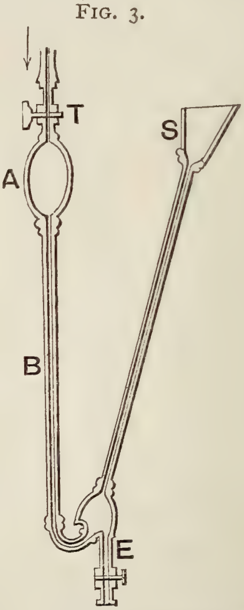
Further instructions say that the lifting must be continued until some drops of mercury come out at *d*. The nature of the valves *c* and *d* is not stated; they appear to have been such as were used in the current form of mechanical air-pump.

In the above description and figure, Swedenborg's lettering is adhered to, but it may be convenient to state that in all the following cuts the lettering adopted is as follows:—

A.—The "pump-head" or hollow globe, which is filled and emptied.
B.—The barometric column or tube, also called the "shaft" of the pump.
b.—Barometric gauge.
D.—Drying apparatus.
E.—Eject-tube or valve.
F.—"Fall-tube."
G.—Gauge.
g.—The flexible lifting tube connecting S and B.
H.—Overhead-tube.
J.—Mercury valve.
K.—Collecting chamber.
L.—Pressure chamber at bottom of shaft.
M.—Second chamber for partial vacuum.
N.—"Side-tube."
P.—Piston.
p.—Plug of rubber.
R.—"Receiver."
r.—Regulating pinch-cock.
S.—"Supply-vessel," or reservoir of mercury.
s.—Rubber packing.
T.—Tap.
t.—Air-trap.
U.—The valve opening inwards from the exhaust tube to the lower end of the pump-head.
V.—The valve opening outwards at the upper end of the pump-head.
W.—Winch.
Y.—Three-way communication to atmosphere, or auxilary pump.
Z.—Return-tube for mercury.

Sixty years elapsed before a second form of mercurial pump was devised, by Dr. Joseph Baader,* who, about 1784, devised the pump depicted in Fig. 3. This pump consisted of a

FIG. 3.



BAADER'S PUMP. (FIRST FORM.)

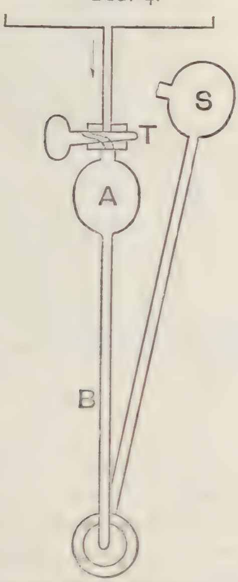
hollow ellipsoidal vessel, A, at the summit of the barometric column, B, terminating above in a passage containing a three-way tap below it, bent round into a chamber with an outlet-tap, and having a second rigid tube, inclined at an angle, ending above in a funnel-shaped vessel

* Swedenborg. "Miscellanea observata circa res naturales, el praesertim circa mineralia, ignem, et montium strata." Lipsiæ, 1722, p. 101. See also "Gren's Journal," vol. iv., p. 407.

* Baader. See Hübner's "Physikalisches Taschenbuch." Salzburg, 1784, p. 630, referred to in Gehler's "Physikalisches Wörterbuch," vi., p. 602 (Ed. 1831).

to receive the mercury. To work this pump, the bottom tap was closed, and the three-way tap was turned so as to make the pump-head, A, communicate with the outer air. Mercury was then poured into S until A was filled; the three-way tap was then turned to cut off communication with the air, and to connect A with the receiver or other vessel to be exhausted. The bottom tap was then opened, and a portion of the mercury permitted to run out until the top of the barometric column was below A, producing a partial vacuum in the pump-head and the receiver. The lower tap was then closed, the three-way tap returned to its former position, and the mercury which had flowed out of the pump was poured again into S, and the operation repeated. It will be obvious that this operation is equivalent to raising and lowering the supply-vessel, as in the pumps of Geissler and Toepler, and their prototype of Swedenborg. Baader had a curious history. In 1784, when this pump was devised, he was studying in Vienna. He afterwards went to

FIG. 4.

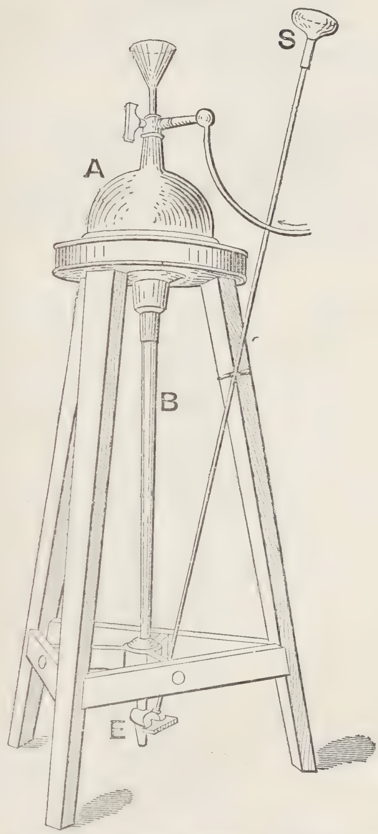


BAADER'S PUMP (SECOND FORM).

Göttingen, thence to Edinburgh, where he took the degree of Doctor of Medicine; but he quitted the medical profession for that of mining, and was afterwards connected with an iron works at Wigan. Gehler states that Baader abandoned his first form of pump in favour of a second,* shown in Fig. 4, which differs from Fig. 3 in having the supply-vessel capable of being raised and lowered, not by a flexible tube, but by turning it about on a joint provided at the meeting point of the barometric tube and the supply tube.

A very finely-constructed pump, on Baader's principle exists in the collection of apparatus in the physical laboratory of University College, London, having apparently been acquired in April, 1828. There is no maker's name or date on the apparatus, but it belongs to, and is catalogued as being "the Torricellian part" of a fine double-barrelled air-pump (price £100) by the famous instrument maker John Cuthbertson, of Amsterdam and London. It is shown in Fig. 5. The exhaust-

FIG 5.



PUMP IN UNIVERSITY COLLEGE.

pipe of brass leads from the three-way tap at the top to a union joint below the plate of the mechanical pump, so that the exhaustion hav-

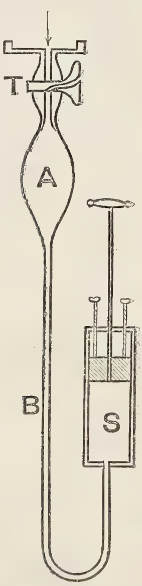
* Baader. See Hübner's ' Taschenbuch,'' cited above; eferred to, with figure, in Gren's "Journal der Physik," ii., p. 326; see also Hindenburg. "De Antlia Baaderiana," 4to Leipzig, 1787, referred to in Young's "Lectures on Natural Philosophy." A quarto volume published at Bayreuth, in 1797, under the title "Theorie der Pumpen," is possibly by the same Baader.

ing been carried in the ordinary way to a certain point, it should be completed by using the Torricellian part. The apparatus is mounted on a massive tripod of mahogany; the fittings of the taps are of metal (steel or iron ; the height from floor to the top of the exit funnel is just under two metres ; the height from the bottom tap to the bottom of the pump-head is just over 1 metre. The barometric tube, B, is of glass, as is also the supply tube. The pump-head is a substantial glass vessel, almost exactly 1 metre in external circumference, hence it would require about 400 lbs. of mercury to work the pump. Prof. Carey-Foster states that it is believed to have been acquired by Dr. Lardner's direction; he has no knowledge of its having been used. I have not been able to discover in any of Cuthbertson's pamphlets or price-catalogues now extant any reference to this part of the apparatus.

A pump on the same principle was patented in 1881 by Mr. Rankin Kennedy. It is described later.

In 1787, C. F. Hindenburg* described the pump shown in Fig. 6, closely resembling

FIG 6.



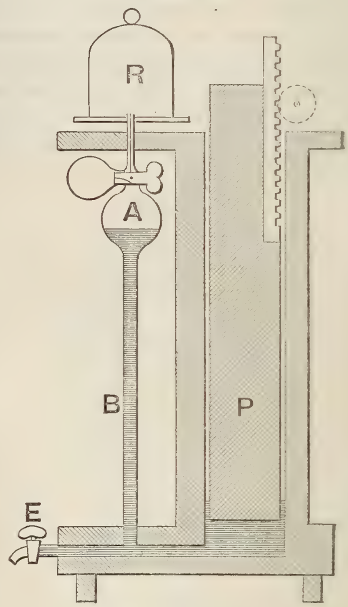
HINDENBURG'S PUMP.

Baader's, but having a piston and cylinder for the purpose of driving the mercury up and down in the barometric tube.

Cazalet,* of Bordeaux, states, in 1798, that he has constructed an apparatus like Hindenburg's, of glass and iron, and that he has succeeded with it in getting an exhaustion of one millionth of an atmosphere; how he measured this does not appear. A similar kind of pump appears to have been used by Michel.†

In 1804, A. N. Edelcrantz‡ published a "Description of a Mercurial Air-pump of unlimited exhausting power, with a wooden piston." This pump (Fig. 7), which appears

FIG. 7.



EDELCRANTZ'S PUMP.

to have been independently conceived, is on the same lines as Hindenburg's, but with superior mechanical arrangements. The three-way tap, instead of being bored diagonally toward the handle, is bored toward the outer end, as in the modern Geissler pumps, and the wooden piston (P) is moved in its stout wooden casing by a rack and pinion motion.

Some years after this "Nicholson's Journal" contains a description of Traill's§ apparatus, which has already been mentioned. It drew a further communication from R. Bancks,

* Hindenburg. See Gehler's "Physikalishes Wörterbuch," vi., p. 603 (1831 edition), which refers to Hindenburg, "Antliæ novæ hydraulico-pneumaticæ mechanismus et descriptio." Leipzig. 4to. 1787. Young mentions also Hindenburg, "De Antlia Baaderiana." Leipzig. 4to. 1787; and to Hindenburg "De Antlia Nova," Leipzig. 4to. 1789.

* Cazalet. "Gren's Journal," i., p. 478.

† Michel. See "Gren's Journal," ii., p. 129.

‡ Edelcrantz. "Nicholson's Journal," vii., p. 188.

§ Traill. "Nicholson's Journal," xxi., pp. 63 and 161.

instrument maker in the Strand, that he had constructed similar apparatus for Mr. Children at a prior date.

In 1824, Joseph H. Patten* wrote an "Account of a New Air-pump," which, like those of Hindenburg and Edelcrantz, had a piston to raise and lower the mercury, but which in another point more nearly resembled the original pump of Swedenborg. The pump-head consisted of a wide-mouthed glass globe, on the top of which was fixed a flat metal plate with a raised rim. In the centre of this was adopted a metal pipe, having a valve opening downwards below it. This valve, a mere metal plug, was held upon a stiff wire which entered the tube above, and was continued downward to the summit of the barometric tube, where it ended in a ball float. When the mercury rose it lifted the ball and closed the valve, and maintained it closed till it once more fell. The air in the pump-head was expelled through a separate valve opening outward in another part of the plate. Patten suggested that, instead of the stiff wire, ball, and valve, the exhaust tube should be prolonged downwards to near the bottom of the globe. The publication of this description drew from Professor J. F. Dana† some remarks suggesting, apparently without knowledge of prior inventors, that it would be preferable to use a three-way tap. To this Patten replied in a later issue in a strongly personal vein.

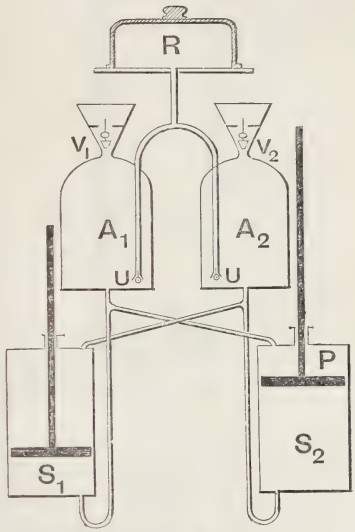
A more complex form of pump, in which the mercury was moved by air-pressure, applied by pouring mercury into a second vessel containing air—somewhat on the plan of Hero's fountain—was described in 1824 by Dr. E. Romershausen,‡ and in 1825 by Uthe.§ In each case a complicated six-way tap was requisite.

In the same year a pump by Oechsle|| was described, having a three-way tap connecting the pump-head alternately with the air and with the receiver to be exhausted, and provided also with a barometer gauge beneath the receiver. The mercury was lowered and raised, as in Edelcrantz's pump, by a large wooden piston, but worked by a chain and winch.

Next in strict historical order is the very remarkable pump of Mile, 1828, which, however, belongs to the third class of machines.

K. T. Kemp,* of Edinburgh, in 1830. designed a remarkable double-acting pump. In this machine a winch, manipulated like that of the ordinary mechanical air-pump, moves two pistons up and down in two cylinders (Fig. 8). These are full of mercury, which is

FIG. 8.



KEMP'S DOUBLE-ACTING PUMP.

thereby driven alternately into the two exhausting-chambers, and which serve as pump-heads. They are provided with valves to admit air from the receiver, and also with valves opening outwardly to let out the expelled air. The latter pair of valves are ingeniously provided with floats, so that they close while there is still some mercury remaining above the actual valve to seal the joint and make it air-tight. The double-pump of Gardiner described below (Fig. 17), closely resembles that of Kemp.

The year 1855 brings us to the famous pump of the late Dr. H. Geissler, of Bonn, which in his hands did such excellent work for exhausting the Geissler vacuum-tubes. The first public mention of this pump appears to be in a pamphlet entitled, "Ueber das geschichtete elektrische Licht" published in

* Patten. "Silliman's Journal," viii., p. 144, 1824, and ix., p. 92, 1825. An almost identical apparatus, called an "oil air-pump," by Sadler, is described by Gehler, vi., p. 606.

† Dana. "Silliman's Journal," viii., p. 275.

‡ Romershausen. "Neue hydrostatische Luft-pumpe." "Kastner's Archiv für Naturlehre," ii., p. 359, 1824.

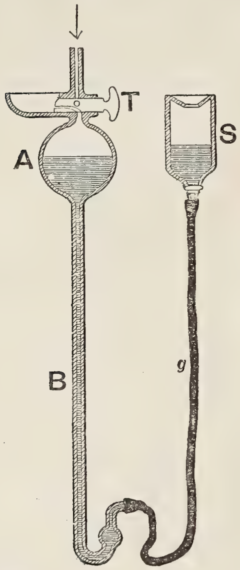
§ Uthe. "Dingler's Polytechnisches Journal," xvii., p. 272, July, 1825.

|| Oechsle; see Wucherer: Beschreibung einer grossen Quecksilbernen Luftpumpe, welche sich in dem physikalischem Cabinet in Karlsruhe befindet. "Kastner's Archiv," v., p. 329, 1825.

* Kemp. Description of a new Toricellian Air-Pump. "Edinburgh Journal of Natural and Geographical Science," ii., p. 95, 1830. See also in Fechner's "Repertorium des Experimentalphysik," i., p. 116; and Taf. 2, Fig. 13, 14, 1832. Also "Baumg. und Ett. Zeitschr.," viii. 193.

Berlin in 1858 by Dr. W. H. Theo. Mayer. The form at first given to this apparatus is shown in Fig. 9; which shows the vessel containing

FIG. 9.



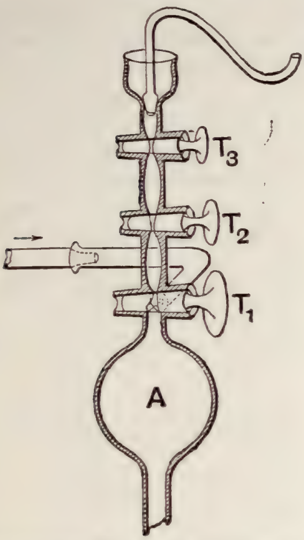
GEISSLER'S PUMP (FIRST FORM).

the supply of mercury, S, connected to the lower end of the barometric column, B, by a flexible india-rubber tube, *g*. The pump-head, A, is provided at the top with a large three-way tap, T. The operation of this simple contrivance is obvious: the air in the pump-head is repelled by raising the supply-vessel, whilst the tap is in such a position that the pump-head communicates with the outer air. The tap is then turned so that the communication with the outer air is cut off, and communication is established with the vessel to be exhausted. This being done, the supply vessel is lowered down, when the mercury in the pump-head sinks, and draws in air through the exhaust tube. The tap is then turned again, and the supply vessel is again raised to expel the air that has been drawn in, then the tap is turned and the supply vessel again lowered. By repeating these operations a sufficient number of times, the air remaining in the apparatus is reduced to a very small portion of its original amount, and the column of mercury in the tube, B, stands up to very nearly the height of the barometer. The perfection of the vacuum is limited by two causes: the inherent imperfection in the three-way tap, and the impossibility of expelling the film of air which adheres to the inner surface of the pump-head. However perfectly the tap may be ground into its seat, however carefully it is lubricated with stiff grease, still air-films will remain between the working surfaces. There is a tendency for a channel to be formed in the film of grease at that part of the conical periphery of the tap where the apertures into it slide round against the internal wall of the glass seat; and through this channel in the glass minute bubbles of air force their way. Moreover, the grease itself may give off vapours which spoil the perfection of the vacuum. The Geissler pump is, moreover, subject to other defects, amongst which may be enumerated the heavy labour of raising and lowering the supply vessel, the liability to accident to the glass top, the liability to fracture of the pump-head. The latter accident occurs not unfrequently, if, after a certain degree of exhaustion has been attained, the supply vessel is suddenly raised, for then, there being little or no air in the pump-head to serve as a cushion, the mercury rising in the pump-head strikes with a sudden blow against the upper portion of the pump-head and fractures it. The long barometric tube or shaft of the pump is also liable to fracture. The working of the tap, being done by hand, requires continuous attention; lastly, the process of exhaustion is slow.

The subsequent improvements relate to the removal of one or other of these drawbacks. Some of them were introduced by Dr. Geissler himself, and by his successor, Herr F. Müller, of Bonn. The form depicted in Fig. 9 (taken from Toepler's paper in "Dingler's Polytechnisches Journal," clxiii., p. 426, 1862) shows the kind of three-way tap (a modification of Senguerd's) originally used, in which the passage for the expulsion of the air was carried through the conical body of the tap to its end. In another form, the same kind of tap was used, but the exhaustion was made through this longitudinal passage, the external tubular seat being prolonged and connected with the vessel to be exhausted. In this case the air was expelled upwards through the transverse passage through the tap. In yet a third form the exhaust tube was sealed on at right angles to the external barrel, and the tap was pierced (on Babinet's plan) with a three-way transverse passage. In the most recent form given to the Geissler pump by its makers, there are three taps, one of them, a large one, being a three-way tap of the last-mentioned kind, simplified by having only one transverse bore of conical

form. The arrangements of this pump are shown in Fig. 10, in which T_1 is the three-way tap, and T_2 and T_3 plain taps of a smaller size. The use of the two upper taps is to enable the last traces of air to be more per-

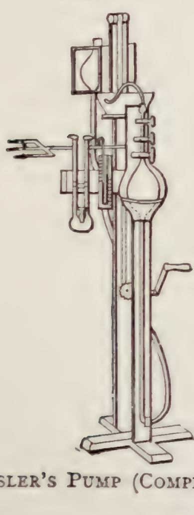
FIG. 10.



GEISSLER'S PUMP (RECENT FORM).

fectly expelled from the pump-head. During the ordinary working of the pump the two top taps are always left open. After the ex-

FIG. 11.



GEISSLER'S PUMP (COMPLETE).

haustion has reached a sufficient point, the large tap is turned so as to cut off communication with the exhaust tube, and to open communication from the pump-head upwards through all the taps. The supply vessel is then raised so high as to drive the mercury up above the level of the topmost tap. The top tap is then closed, and, by sinking the supply-vessel, the mercury is caused to fall below the pump-head. It is then slowly raised, driving before it all the air that may remain in the pump-head, and collecting it just below the top tap. As soon as the mercury has risen through the second tap, this is then closed, and the mercury once more lowered. It will be seen that if the space between T_2 and T_3 is sufficiently great, this residual air will not become compressed to anything like atmospheric pressure, and hence the air-films forming in the upper part of the pump-head or in the channels of the three-way tap will be comparatively slight. The curved tube at the top is used for collecting the gases extracted in chemical operations ; the horizontal exhaust tube is usually connected with drying-vessels, and with appropriate gauges. The complete pump as used for the purposes of the chemical laboratory as shown in Fig. 11.

Morren's pump* is practically identical with Geissler's, save in a detail concerning the three-way tap, which has, instead of having a glass cone with a longitudinal passage pierced through it, a steel cone, with a channel or groove cut in the side. Another almost identical form was described by G. Jolly,† about the same time. It resembled Geissler's first form, but was provided with a mechanica device of a winch and pulley, to raise and lower the supply-vessel. This device was speedily adopted by other makers; it may be seen in the latest form of Geissler's pumps. Jolly's pump also has a steel three-way tap. Von Babo‡ sought to replace the egg-shaped pump-head by a glass cylinder, strongly held together between circular steel ends, and having two automatic valves opening into and out of it, precisely as in Kemp's pump of 1830 (Fig. 8). Poggendorff§ further improved the mechanical lift by adding a counterpoise weight. Alvergniat|| introduced an automatic valve into the exhaust tube, to prevent the mercury from being driven

* Morren. "Annales de Chim. et de Phys." March, 1865. See also, "Carl's Repertorium der Physik," vol. i. p. 142, 1866. It is depicted in Ganot's "Physics" (1879), p. 158.

† Jolly. Ueber eine neue Einrichtung der Quecksilber-Luft-Pumpe. "Carl Repert," i. p. 144. 1866. See also Müller-Pouillet's "Physik" (ed. 1876), vol. i., p. 231; and Mousson's "Physik" (ed. 1879), i., 1878.

‡ Von Babo. See "Müller-Pouillet," i. 233.

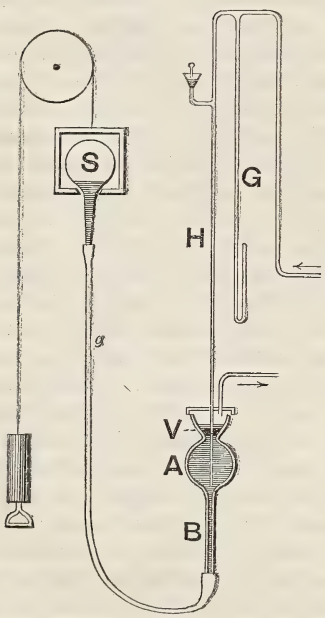
§ Poggendorff. "Pogg. Ann.," cxxv., 151.

|| Alvergniat. See Pellat, "Cours de Physique," (1883) i., 319.

back into the exhausted vessel. Weinhold * modified the glass three-way tap, and added above it a small chamber, above which the opening into the outer air was closed by a second glass tap of simple construction. The use of this upper chamber to secure a more perfect vacuum brings this form almost into identity with Geissler's later form. The device of interposing such a chamber between the three-way tap and the external air was independently suggested in 1875 by Kundt and Warburg,† and appears to have been already adopted by Geissler ‡ in 1873.

In the years 1873 and 1874, Dr. Joule § devised several forms of mercurial pump, having but one valve, an india-rubber plug, V, fitting into a cone seat at the top of the pump-head, allowing the air to be expelled. A little

FIG. 12.

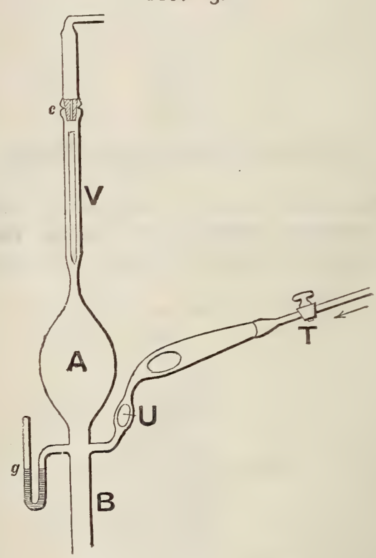


JOULE'S PUMP.

mercury above it kept the joint secure. The necessity of emptying a second valve was obviated by the device (previously used by Mile) of connecting the vessel to be exhausted to the pump by means of an overhead tube, H, of more than barometric height which passed into the pump-head, its open lower end descending nearly to the bottom of the chamber. This acted automatically as a trap; for, on the raising of the supply-vessel, the mercury rising in the pump-head first closed the orifice of the head-tube, so cutting off communication with the air that remained in the pump-head, but never rising in that tube to a height greater than 76 centimetres above the level of the valve. Another feature of Joule's pump was that the supply-vessel was closed at the top, being made of a globular flask. By allowing only a certain amount of air to enter this flask, the pressure inside was kept at less than atmospheric, enabling the length of the shaft, B, to be reduced. Later, a conical ground-glass tube was used in place of the india-rubber plug for a valve.

In 1873, Mitscherlich * altered the pump in the manner shown in Fig. 13. The

FIG. 13.



MITSCHERLICH'S PUMP.

double function performed by the three-way tap was in this form shared between an automatic valve, V, opening upwards only, and a plain glass tap, T, worked by hand. The valve consisted of a rod of glass, ground conical at its lower end, fitting into a tube of one centimetre internal diameter. This rod was raised from its seat by the mercury as it rose through the pump-head. A perforated cork placed in the eject tube above the valve prevented it from rising too high, otherwise it would, in falling, become jammed. The

* Weinhold's. "Physikalische Demonstrationen" (1883) p. 175. See also "Carl's Repert," ix., p. 78, 1874.

† Kundt und Warburg. "Pogg. Ann.," 526, 1875.

‡ See Bessel-Hagen. "Wied. Ann.," xii., 436, 1881.

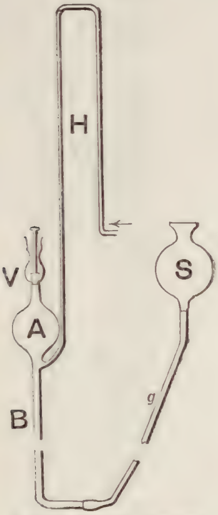
§ Joule. "Proc. Lit. Phil. Soc. Manchester," xii., 57, 1873; ib. xiii., 58, 1874; ib. xiv., 12, 1875; see also "Scientific Papers," i., 623; also "Catalogue of Loan Collection of Scientific Apparatus," 1876, p. 133.

* Mitscherlich. "Pogg. Ann.," cl, 420, 1873.

exhaust tube communicated with the pump through the tap, T, at a point below the pump-head; the communicating tube being enlarged to receive anhydrous phosphoric acid or other drying materials, the same being protected from the rising of the mercury by the interposition of a loosely-fitting glass valve of ovate shape, U.

Another modification, due to Lane-Fox,* is shown in Fig. 14. The valve at the top of the

FIG. 14.



LANE-FOX'S PUMP.

pump-head is a conical glass stopper ground to fit tightly into its seat, requiring to be removed and replaced by hand. The overhead tube, H, which acts as a barometric trap, is joined to the shaft of the pump just below the pump-head. Lane-Fox also suggested the use of an automatic valve (like that of Alvergniat) to obviate the necessity of using the tall head-tube. This pump was for a long time used by the Anglo-American Brush Electric Light Corporation for exhausting the Lane-Fox incandescence lamps; they introduced a number of modifications in detail, one of which consisted in replacing the stopper, V, by an automatic valve resembling Mitscherlich's. A side-tube leads from below the lower automatic valve, U, to the tap of the pump-head. There is also a spark-gauge. A drawing of one of the intermediate forms of Lane-Fox pump is given in Gordon's "Electric Lighting," (1884) p. 83.

About the same date, minor improvements were suggested by several persons. Mr. Dewar Smith, of Cambridge, suggested the use, at the top of the pump-head, of an automatic valve consisting of a strip of rubber or silk stretched over an orifice, precisely as in many mechanical air-pumps, the valve itself being surrounded by an upper mercury cup to ensure a tight joint. Messrs. Goebel and Kulenkamp,* who used an automatic glass valve to close the top of the pump-head, adopted above it a flexible tube, by means of which to return to the supply-vessel the small quantities of mercury which from time to time were driven up through the pump-head, with the ejected air. Guglielmo,† applying a very similar device, achieved the not unimportant result of causing the tap at the top of the pump-head to discharge the ejected residual air into a space already partially exhausted. This he accomplished by interposing in the flexible tube connecting the summit of the pump-head with the closed top of the supply-vessel a vertical glass tube, about 20 centimetres long, with a three-way tap opening also into the air. Through this tap atmospheric pressure could be momentarily established when the supply vessel was in its lower position, and nearly full of mercury. When it was raised, the mercury ran out of it into the pump-head, leaving the space in it partially exhausted; and into this vacuous space the three-way tap at the top of pump-head opened to let out the ejected air. As will be seen later on, this device makes this pump resemble somewhat some pumps of the third group.

Mr. Albert Geissler‡ has replaced the three-way tap by two automatic valves (Fig. 15, p. 30) one of which, V, opens from the top of the pump-head into the outer air; the other, U, admits air from the vessel to be exhausted into the pump just below the pump-head, as in the Mitscherlich and Lane-Fox pumps. These valves are hollow tubes of glass, with spindle ends to guide their motion, which float in the mercury when it reaches them. They are provided with accurately ground glass collars instead of conical ends, to fit against the ends of the tubes which they respectively close. An additional tap, T, is interposed for safety between the pump and the vessel to be exhausted. Other tubes lead to the manometric gauge and to the drying apparatus. This form of pump is intended for industrial use,

* Lane-Fox. Patent Specification 3494, of 1880.

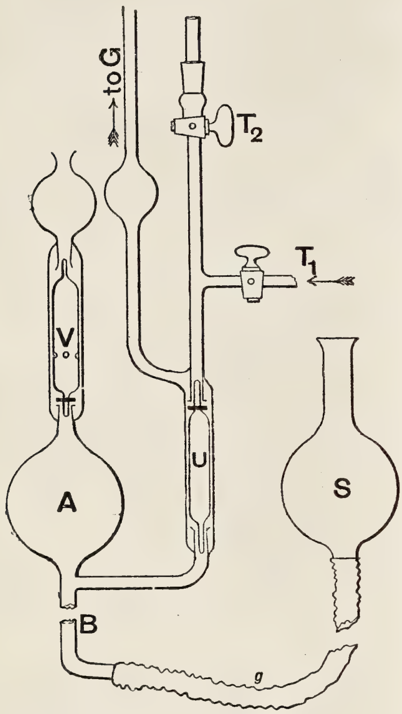
* "Wied. Beiblätter," vi., 849. 1882. See also Specification of Patent 5,548 of 1881.

† Guglielmo. "Wied. Beibl," viii., 739, 1884.

‡ A. Geissler. "Centralzeitung für Optik and Mechanik," vii., 12. 1886; also D. R. Patent, No. 32,224, 1885.

where power is available to keep the supply-vessel slowly rising and sinking. A small improvement of recent date, due to Messrs. Greisser and Friedrichs* consists of a new three-way tap of peculiar construction, pierced with two transverse channels at 45°. Of the three openings, two are at one side of the barrel, one at the other, so that the top has to

FIG. 15.

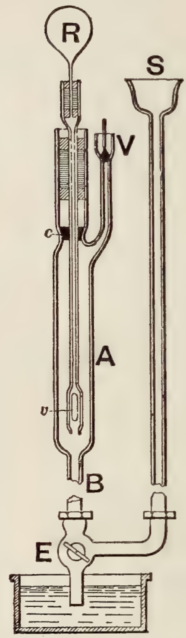


ALBERT GEISSLER'S PUMP.

be worked through 180° instead of 90°, and the channels in the grease do not lead directly from one aperture to another. Hence there is a lesser risk of leakage.

In 1881, Mr. Rankin Kennedy† prepared a pump for exhausting lamps, going back in principle to that of Baader. Mercury is passed down a supply tube, S (Fig. 16) and rises with the pump-head, expelling the air through a valve, V. Then a three-way eject tap, E, at the bottom is turned, cutting off communication with S, and allowing all the mercury in the pump-head to run out into a basin below. The lamp, or other vessel, R, to be exhausted, is joined in through an aperture at the top of the pump-head by means of a tube passing in through an india-rubber cork, *c*, and sealed above by a mercury joint. This tube is also supplied with an automatic valve, *v*, at its lower end, to allow it and the exhausted lamp to be removed from the pump, in order to seal it off. A similar device had also been described by Akester. Akester's pump* closely resembled that of Lane-Fox; but in it the raising and lowering of the supply-vessel was obviated by using, at the bottom of the pump-shaft, a

FIG. 16



KENNEDY'S PUMP.

three-way tap, enabling the barometric column to be placed alternately in communication with a supply cistern placed at a high level, and with a return-pipe through which the descending mercury flowed away at a lower level, to be again pumped up to the high level by a mechanical pump. Another way of raising and lowering the mercury in the pump, which also dispensed with flexible tubing, was suggested by Rock † (A similar device was suggested by Mile in 1830.) The pump-head and barometric column are formed by a single straight cylindrical tube, about 100 centimetres long, 10 centimetres in internal diameter of glass, and 1 centimetre in thickness. It is open at the bottom, but closed in and furnished with the usual three-way tap at the top. Outside it is a

* Greisser and Friedrichs. See "La Lumière Electrique," xxiii. 335, 1887.

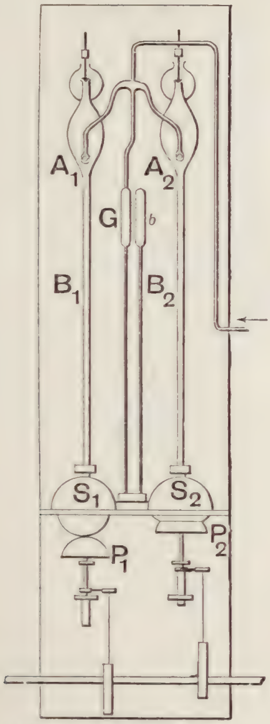
† Kennedy. Specification of Patent, 5,524 of 1881. See also Dredge's "Electric Illumination," ii. p ccxxxii.

* Akester. See Specifications of Patents, 4,458 of 1881, and 2,519 of 1882.

† Rock. "Wied. Beibl," vii., 790, 1883.

second, slightly longer, tube, having an internal diameter of 12·6 centimetres. This—the supply-vessel—is closed at the bottom, and can be raised or lowered mechanically. If the outer one, filled with quicksilver, is raised, the liquid forces its way up the inner tube, driving the air before it, through the three-way trap. When it is lowered, the mercury remains inside, to a height which will never exceed 76 centimetres above the level of the mercury in the outer tube, the space above being left vacuous. The inventor claims that this construction is less liable to give trouble than the usual form. Cruto* has used a somewhat similar device, but with sulphuric acid instead of mercury in the pump. To obviate having to work with a pump-shaft twenty feet long, he adopted the device of an auxiliary exhaust pump. Narr† has described a simple pump on Jolly's plan, but

FIG. 17.



GARDINER'S DOUBLE PUMP.

having steel taps, the pump-head of glass being united above and below to the working parts by carefully-ground and lightly-greased steel unions, clamped together by screws. By reason of its strength, this construction seems to be preferable in cases where very high vacua are not required.

Double-action pumps have been suggested by various persons. Kemp's pump (Fig. 8) was of this class, so is one by Serravalle,* in which there are two supply-vessels, so arranged that while one rises the other descends; two separate pump-heads, with two three-way taps automatically opened and shut; and two exhaust tubes uniting into one. Another double pump, by Gardiner,† depicted in Fig. 17, is worked mechanically from a rotating shaft. Two eccentrics drive alternately up and down two hemispherical pistons, P_1 and P_2, which press in the flexible hemispherical bottoms of the two supply-vessels. The valves of this pump are all automatic, as in Kemp's pump. It is provided with a barometric gauge, G, and a comparison barometer, *b*.

SUB-CLASS I*a*.—SHORTENED UPWARD-DRIVING PUMPS.

The length of the pump-shaft in the preceding cases being necessarily equal to that of the barometric column, renders all these forms of apparatus more or less unwieldy. Although a column of mercury 76 centimetres high is a necessity for working between vacuum within and atmospheric pressure without, no such length is required when working between vacuum and a reduced pressure. In fact, the length of the pump may be shortened by reducing the pressure of the air above the surface of the mercury in the supply vessel, in all pumps of Class I. and Class II. The first suggestion for shortening the pump came from the Rev. Professor Robinson,‡ in 1864, and was almost immediately followed by one from Professor Poggendorff.§ In these apparatus a common air-pump worked by hand was used to produce a partial vacuum. The pump-shaft was quite short, and ended in an auxiliary chamber, closed at the top, but having a tap communicating either with the auxiliary pump or with the outer air. The three-way tap above the pump-head also opened into a tube which could be made to communicate either with the auxiliary pump or with the outer air. To fill the pump-head with

* Cruto. Specification of Patent, 1895 of 1882.

† Narr. Ueber eine Abänderung der Jolly'schen Quecksilberluftpumpe. "Wied. Annalen," 542, 1885.

* Serravalle. "Riv. Scient. Industr.," xiv., 401, 1882; also "Wied Beibl," vii., 490, 1883.

† Gardiner. See "La Lumière Electrique," xiii., 219, 1884

‡ T. R. Robinson. "Description of a New Mercurial Gasometer and Air-pump." "Proc. Roy. Soc." xiii., 321, 1864. *Phil. Mag.*, xxviii., 235, Sept. 1864.

§ Poggendorff. "Pogg. Ann.," cxxv. 151, 1865. See also Müller-Pouillet's "Physik" (1876), i 233.

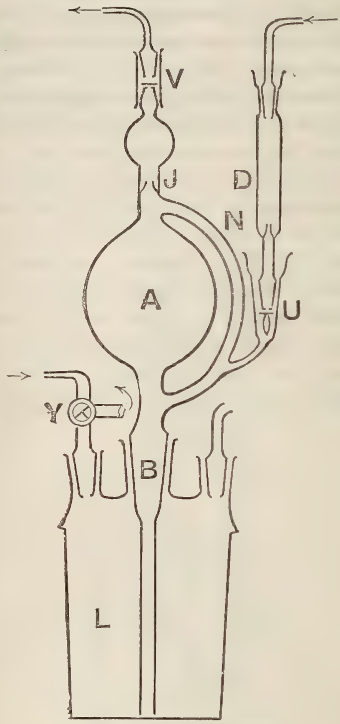
mercury, air was admitted to the auxiliary chamber, whilst at the same time the auxiliary pump was applied at the top to suck the mercury into the pump-head. The three-way tap being then turned to put the pump-head into the vessel to be exhausted, the auxiliary pump was used to reduce the pressure in the auxiliary chamber, causing the mercury in the pump-head to fall, the height of the column representing always the difference between the pressure in the pump-head and that in the chamber.

Several later experimenters have adopted this device of applying an auxiliary pump to shorten the vacuum pump; and as we shall see, the device is applicable to each of the three main classes of pumps. Dr. F. Neesen,* whose more recent pump is described later, adopted this device in 1878. At that date he was employing a shortened Geissler pump, to which, independently of Mitscherlich, he had applied an automatic exit-valve above the pump-head. He had also introduced another notable improvement, namely, a side-tube, connecting the exhaust-tube from a point a little beyond where it branched off from the pump-shaft to a point above the pump-head below the automatic valve. Such a side-tube, marked N in the Figs. 18 and 33, prevents the fracture of the top of the pump-head by air bubbles suddenly rising through the mercury in the barometric column.

Schuller,† in 1881, described another shortened pump, with numerous carefully considered details, and a curious automatic method of operating, which, however, need not here be described. Fig. 18 shows Schuller's pump. V and U are automatic valves consisting of small pieces of flat glass, preferably triangular, which close the mouths of tubes that have been also carefully ground flat. In the valve V, shown in detail in Fig. 19, the weight of the small glass plate is partly sustained by the ring of mercury surrounding the tube end above which it lies.

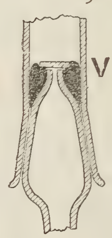
Another feature of Schuller's pump is the valve J, situated in the tube between the pump-head and the upper valve V. This valve J, shown larger in Fig. 20, is composed wholly of mercury, which, during the descent of the body of liquid down the tube, forms, by virtue of its great surface-tension, a cap over the orifice three millimetres in diameter, which is here interposed. As in Geissler's later pumps, there is an auxiliary chamber, M, between V and J, in which a partial vacuum is formed, so that the residual air expelled from the pump-head

FIG. 18.



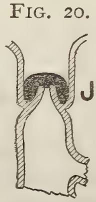
SCHULLER'S PUMP.

FIG. 19.



DETAIL OF VALVE.

FIG. 20.



SCHULLER'S MERCURY VALVE.

is driven into an already exhausted space. The little vault of mercury over the aperture in J is able to withstand the difference of pressure

* Neesen. "Wied. Ann." iii., 608, 1878; also "Zeitschrift für Instrumentenkunde" ii., 287, 1882.

† Alois Schuller. "Wied Ann." iii,, 528, 1881.

between the partial vacuum above and the nearly perfect vacuum below it. At the commencement, a partial vacuum is made in the pump-head, through the upper valve, by an auxiliary mechanical pump. A three-way tap, Y, suffices to put the space in the bottle, L, alternately into communication with the atmospheric air, and with a tube leading to an auxiliary mechanical air-pump.

Another pump of this class, by Dittmar*, has simply two plain glass taps, one above, the other in the exhaust-tube at the side of the pump-head. It obviously could not give a good vacuum.

The most recent pump in this category appears to be that of M. A. Joannis.† The ordinary three-way tap at the top of the pump-head communicates with the open air; below, at the lower end of the pump-shaft, is a closed vessel, communicating by another three-way tap with a water aspirator, and with a source of pressure by means of which the mercury is alternately raised and lowered.

Class II.—Downward-driving Pumps.

The idea of expelling the residual air down a barometric column originated with Dr. Hermann Sprengel,‡ who in the year 1865 brought out the pump which is associated with his name. He had in the preceding years been studying the uses in the laboratory of the water-trombe or aspirator, a much older instrument, used for some hundreds of years for delivering air under pressure. The theory of this ancient apparatus had already received the attention of Magnus,§ and of Buff,‖ and Sprengel¶ had himself devoted some attention to this method of furnishing air for the blowpipe. It appears to have been an original idea with him to substitute falling mercury in the place of falling water, in order to extract gases by means of the vacuum produced above the column.

The form of the original Sprengel pump is shown in Figs. 21 and 22. The supply-vessel, S, was, in this case, a funnel fixed at the top of the apparatus, from which the mercury was delivered at a steady rate through a narrow india-rubber tube, nipped by an adjustable pinch-cock. After passing this point it fell in drops down a glass tube, F, of narrow bore but having strong external walls, and known as the fall-tube. As it fell down this tube in drops, it swept out the air of the tube and the air which entered from the side, each drop acting as a piston to propel the air below it. To secure this action, it is essential that the fall-tube should not be too wide. For rapid, partial exhaustions, an internal bore of 2 to 3 millimetres appears to be about the best size: for slower exhaustions, carried to the highest degree of rarefaction, a bore of 1·4 to 1·8 millimetres appears to be preferable.* During the first stages of the process of exhaustion, whilst yet there is a considerable amount of air in the fall-tube, the successive drops of mercury

Fig. 21.

Sprengel's Pump (Simple Form).

move separately down the tube, almost silently, being separated from one another by the intervening cushions of air, which as they descend the tube become more and more compressed. As a higher degree of rarefaction is attained there is no longer a sufficient cushion of air, the drops fall smartly through the vacuous space with a loud metallic clinking sound as they strike upon the top of the barometric column, which occupies the lower thirty inches or so of the fall-tube. At the bottom of the fall-tube the air and mercury enter a suitable vessel, K, from which, if desired, the air that has been carried down the fall-tube may be collected. The mercury which flows into K

* Dittmar. See "Challenger Report: Physics and Chemistry," vol. I., 1884; plate 3.

† Joannis. Modification de la machine pneumatique à mercure. "Ann. Chim. Phys." Series VI., xi., 285, 1887.

‡ Sprengel. "Journ. Chemical Soc.," Series II, iii., 9, 1865; see also "Pogg. Ann.," cxxix., 564, 1865.

§ Magnus. "Pogg. Ann.," lxxx, p. 32, 1850.

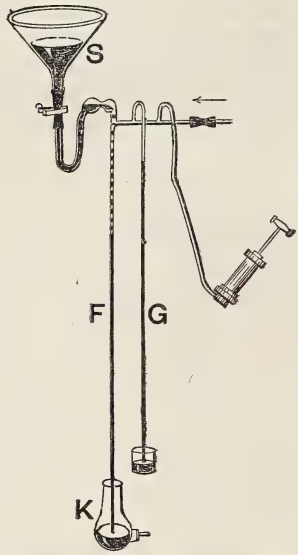
‖ Buff. "Ann. der Chem. und Pharm.," lxxix., 249, 1851.

¶ Sprengel. "Pogg. Ann.," cxii, 634, 1861.

* See Gimingham. "Journ. Soc. Chem. Industry," III. 84, 1884.

must be periodically collected and poured again into the supply-funnel at the top. In the second form (Fig. 22), a downward bend is inserted between the supply-funnel and the point where the mercury begins to break away into drops. This bend leads to a small chamber, virtually the pump-head, from the end of which the mercury falls in drops. The flow is regulated by a pinch-cock, *r*, which can be

FIG. 22.



SPRENGEL'S PUMP (SECOND FORM).

screwed up to nip, more or less tightly, a piece of flexible india-rubber tubing inserted in the supply tube. In this figure there is also shown a small mechanical air-pump for rapidly producing the first partial exhaustion, and barometric gauge, *b*, to show the degree of rarefaction attained.

The introduction of the Sprengel form of pump at once attracted a revived attention to the advantages of mercurial pumps for exhausting, and it was soon in the hands of many experimenters. Graham* applied it to extract minute quantities of gases in his researches on gaseous diffusion; Bunsen† adapted it for the purpose of hastening filtration, employing a form somewhat modified to admit of the use of drops of water instead of drops of mercury. Improvements began to be introduced in the details of construction, as experience revealed the imperfections. It was found that air was liable to be carried down into the pump through the supply-vessel at such times as more mercury was poured in above; it was necessary to trap off such air bubbles to prevent them from vitiating the vacuum already attained. It was found necessary to introduce vessels containing drying materials, such as concentrated sulphuric acid, or glacial phosphoric acid. The fall-tubes were found to have an awkward habit of cracking and breaking off just at a point 30 inches above the lower end, in consequence of the hammering action of the falling drops during the later stages of exhaustion. Better and more reliable gauges were required to verify the degree of rarefaction. Lastly, some remedy was wanted for the difficulty experienced in forcing down through the 30 inches of barometric column the last small traces of residual air in the fall-tube. The falling drops hammered these residual bubbles into the mercurial column below them: the air bubbles, on their part, always tended to rise again into the upper part of the tube; often they would stick to the wall of the glass tube, refusing to move, though the mercury continued to flow past them. The remedy of turning on a more sudden flow of mercury to sweep them out was not always successful. Indeed, when it is remembered that these last residua must be re-compressed to atmospheric pressure, in order to expel them at the bottom of the tube, it would seem strange if such a method of expelling the residual air should prove effectual. Some of the desired improvements were originated by Dr. Sprengel himself, others by instrument makers, who constructed Sprengel pumps for their customers.

An improved joint, made by grinding the conical end of a glass tube into a conical socket at the end of another tube, and placing mercury in the cup surrounding the junction, was described by Dr. Sprengel.

By the year 1874* two modifications had come into extensive use; the mercury, instead of running direct into the pump from the supply-vessel, was carried down a vertical tube, surrounded by a wider external one, so that any air bubbles accidentally carried down escaped up the wider tube instead of entering the pump; also after passing this trap, the mercury was forced up again in a moderately wide tube, ascending to a slightly lower level than the supply-vessel, and again descending.

* Graham. "Journ. Chem. Soc.," xx., 247, 1866. See also "Pogg. Ann.," cxxix., 563, 1866.

† Bunsen, "Ann. Chem. Pharm.," cxlviii., 277, 1868. See also "Ann. Chem. Pharm.," clxv., 159; and "Phil. Mag.," xlv., 153, Feb., 1873. Compare also with water pump of M. W. Johnson, "Chem. Soc. Quart. Journal," 1852, p. 186.

* See E. J. Osmond in "English Mechanic," xix., 372, 1874, giving drawing of Sprengel pump.

The upper bend of this tube communicated at its highest point with a small stoppered chamber, partially exhausted of air by filling it with mercury, which was then allowed to run out. As the mercury passed over this bend, it consequently fell through a partially exhausted space, and was still more thoroughly freed from air before ascending to the head of the actual pump. These improvements are embodied along with others in the form constructed by Alvergniat,* of Paris, who worked for and with the advice of M. H. Sainte-Claire Deville.

In most of the modern Sprengel pumps the mercury is introduced into the pump-head by a jet-tube with a narrow orifice, whence it spurts in a fine stream, and falls into the widened tube of the fall-tube; in some other forms it merely breaks away in drops over a bend in a wider tube. This form is simpler to construct.

A very important addition was the improved gauge introduced by McLeod,† in which was applied the principle of compressing a known volume of the rarefied air or gas into a smaller known volume (the ratio of the two volumes being accurately known) and then measuring its pressure, and so calculating backwards. This method, suggested long before by Arago, and employed by Régnault‡ for the purpose of testing the perfection of the vacuum of a barometer, may be regarded as a refinement upon the method of the "pear-gauge" invented by Smeaton. In Smeaton's invention the residual air left in the pear-shaped glass vessel, placed with its lower end in mercury, under the receiver of an air pump was, on the restoration of the external pressure, driven out of the body of the pear into its narrow upper end, where its volume could readily be measured. In McLeod's original gauge a globe of about 48 cubic centimetres was employed, opening at the top into a narrow volume-tube sealed at the top, and suitably graduated. This apparatus communicated below with the pump, and stood at the top of a barometric column which was provided at its foot with a flexible rubber tube and a supply, vessel, by raising which (by an action like that of Geissler's pump) the mercury could flow up into the gauge, and force the residual air in the bulb into the volume-tube at the top. A neighbouring pressure-tube rendered the increment of pressure (due to compression) evident at a glance, and all that remained to be done was to multiply this increment by the ratio between the volume now occupied by the residual air and volume it originally occupied. McLeod showed how to carry the calculation to a second approximation.

About the same time, Crookes* introduced several improvements in detail:—A method of lowering the supply-vessel to re-fill it with the mercury that had run through the pump; the use of taps made wholly of platinum to ensure tightness; the use of a spark-gauge to test the perfection of the vacuum by observing the nature of an electric spark in it; the use of an air-trap in the tube leading up to the pump-head; the method of connecting the pump with the object to be exhausted, by means of a thin, flexible, spiral glass tube; the method of cleansing the fall-tube by letting in a little strong sulphuric acid through a stoppered valve in the head of the pump. In carrying out these experiments, Crookes was assisted by Mr. Gimingham, whose further contributions to the development of the pump will presently be noticed. It was with this improved pattern of Sprengel that Crookes was able to carry out that remarkable series of researches upon the repulsion accompanying radiation, which culminated, in 1875, in the invention of the radiometer, and later led to the discovery of the phenomena of "radiant matter."

Professor R. A. Mees† described another modification, the fall-tube being constructed with a series of bends constituting fluid valves or traps, in which the minute portions of air carried down the fall-tube might accumulate in order to be swept out the more effectually when aggregated in larger bubbles. This pump also had a peculiar automatic stop-cock.

From 1875 to 1884 a series of modifications were introduced by Mr. Gimingham.‡ Firstly, the process of exhaustion was accelerated by the employment of multiple fall-tubes, receiving their streams from a distributing jet within the pump-head. Three fall-tubes were

* Alvergniat's form is depicted in Violle's "Cours de Physique" (1884), I., 947. The form commonly used in Germany is given in Weinhold's "Physikalische Demonstrationen" (1881), 171.

† McLeod. See "Phil. Mag." (4) xlviii. 110, 1874, and "Proc. Phys. Soc. Lond." i. 30, 1874.

‡ Régnault. "Rélation des Expériences" (1847) i. 491.

* Crookes. "Proc. Roy. Soc.," xxxi., 448, 1881; also "Proc. Phys. Soc. Lond.," i., 35, 1874.

† Mees. See "Catalogue of Loan Collection of Scientific Apparatus," 1876, p. 131.

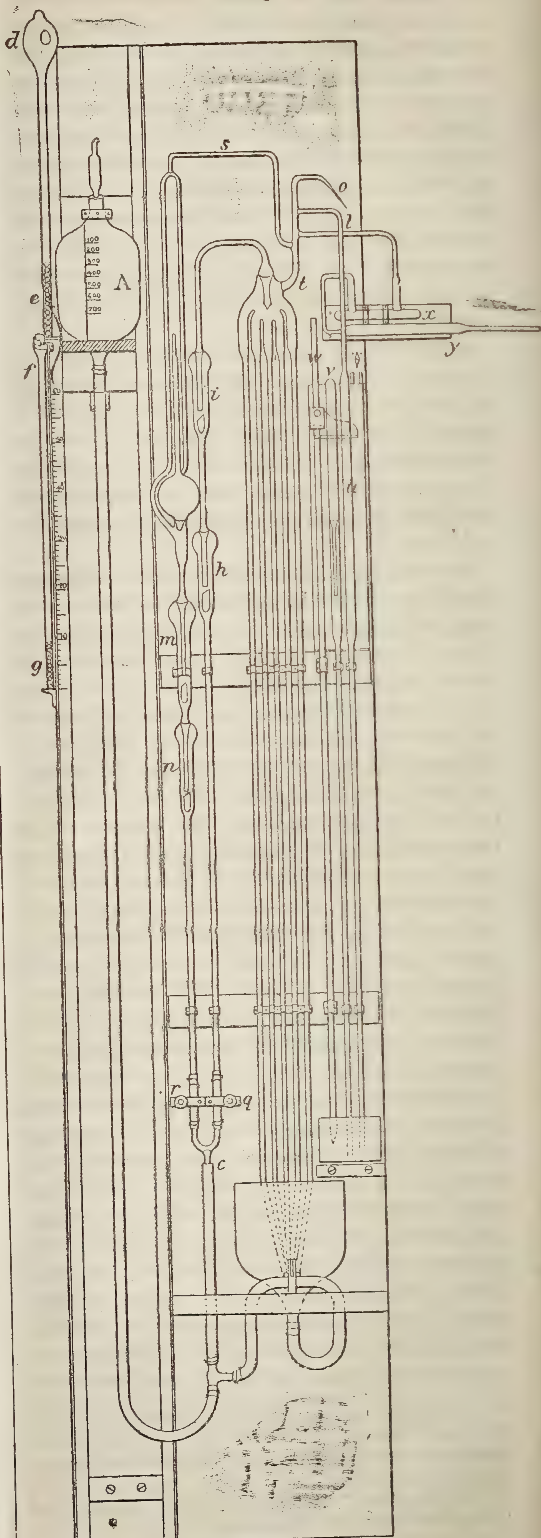
‡ Gimingham. "On a new form of the Sprengel Air-pump." "Proc. Roy. Soc.," clxxvi., 396, 1876; and Contributions to Development of Sprengel Air-pump." "Journ. Soc. Chem. Indust.," 1884.

employed, then five, later seven; but five appears to be a preferable number. In Fig. 23, which embodies Gimingham's various improvements with the earlier ones of Crookes, there are five fall-tubes shown. Careful experiments to determine the best size of bore for the fall-tubes gave the following results when exhausting a vessel of 136 cubic centimes capacity:—

Diameter of Bore in Millimetres.	Rate of flow in cubic centimetres per minute.	Total quantity of Mercury (in cubic centimetres) requisite to reduce pressure to one millimetre of Mercury.	Total time required in minutes.
2·4	83·3	2,500	30
2·4	20	1,600	80
1·8	20	700	35
1·8	50	1,200	24
1·4	10	1,800	180
1·4	25	2,700	120
1·1	20	4,000	200

The enormous time required in the last case was due to incessant choking up of the upper part of the fall-tube, owing to friction in the narrow bore. The conclusion derived from comparison of results with varying bores is that at high degrees of exhaustion the last portions of air or gas are carried out by entanglement with the mercury, and not by the mercury acting in definite "pistons" to sweep out the gas. With respect to the length of the fall-tubes, it was found that those 39 inches (1 metre) long, giving a fall of 9 inches (or 22·5 centimetres), exhausted more rapidly than tubes only 33 inches (85 centimetres) long. Tubes longer than thirty-nine inches were found liable to fracture, in consequence of the severe concussions of the mercury as it fell upon the top of the barometric column. Gimingham also described an improvement in the McLeod gauge, making its indications at once more sensitive and more reliable. Several minor improvements are also mentioned; an improved vacuum tap, an improved form of air-trap, a radiometer gauge, and a bulb containing crumpled gold-leaf, to absorb mercury vapour.

Fig. 23.



Gimingham's Pump.

The lettering in Fig. 23, which is taken from Gimingham's paper in the "Journal of the Society of Chemical Industry," is as follows. The supply-vessel, A, communicates by a long tube with a forked tube, C, leading to two regulating pinch cocks, *r* and *q*. The left-hand tube leads up through two air-taps, *n* and *m*, to the McLeod gauge; the right-hand tube, through two air-traps, *n* and *i*, to the pump-head, where the mercury is thrown in jets into the tops of the five fall-tubes. The tube, *t*, is the exhaust tube, which has three branches, one, *s*, leading to the McLeod gauge, one, *l*, leading to the barometric gauge, *u*, and one leading through the drying-tube, *x*, and the absorbing-tube, *y*, to vessel, lamp, or bulb, which is to be exhausted. A comparison-barometer is placed at *v*, and a measuring rod to read off barometric heights is fixed at *w*. The arrangements at *d*, *e*, *f*, and *g*, relate to a mechanical method of counting the number of times that the supply-vessel has been let down to be replenished.

Mr. Gimingham has also suggested* a mechanical mercurial pump with valves.

A five-fall Sprengel pump, of simpler construction, and jointed with indiarubber tube-joints, is used by the Thomson-Houston Company, in their factory at Lynn, Massachusetts. The Anglo-American (Brush) Company have also used a modified five-fall tube in their works at Lambeth. Another multiple-fall pump has been patented by Mr. Donkin.†

Dr. L. von Babo‡ described an ingenious method of making the Sprengel pump supply itself with mercury, by the device of connecting it to a water-aspirator, worked by a constant stream of water. This aspirator drew in air and mercury at the lower part of the pump, and lifted it up through a narrow tube to a height above the level of the mercury in the supply-vessel. Incidentally, this method has the advantage, apparently not noticed by von Babo, of enabling the fall-tube to be considerably shortened; it has the disadvantage of exposing the mercury to water-vapour during a part of its circulation.

Macaluso§ proposed the addition of a Mariotte's flask, to regulate the flow of mercury, thereby avoiding the need of having a movable reservoir.

* Gimingham. See "English Mechanic," xxxvi., 442, 1882.

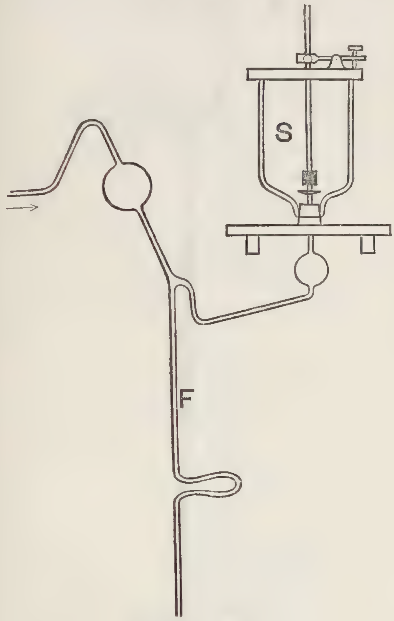
† Donkin. Centralblatt für Optik und Mechanik, vii., 216, 1866.

‡ Von Babo. "Berichten d. naturforsch. Gesellsch. zu Freiburg." ii., Heft. 3., 1879.

§ Macaluso. See "Wied. Beibl," iv., 516, 1880.

Rood,* in 1880, described several details of some novelty; an iron valve in the bottom of the supply-vessel, capable of fine regulation by a screw, served to determine the rate of flow of the mercury. Immediately below the supply-vessel, the mercury entered a vacuum bulb (see Fig. 24), designed to free the mercury from air

FIG. 24.



ROOD'S PUMP.

and moisture, the mercury dropping at once to its lower part, which should be level with the point where the curved supply-tube joins the fall-tube. This bent tube, about 20 centimetres long, after descending gently, ascends about 4·5 centimetres; it is made of about the same diameter in the fall-tube. The fall-tube, as in Mees's pump, is provided with bends. Rood also described a modification of the McLeod gauge. His pump was so mounted that all parts of it could be heated by means of a Bunsen's burner. Great importance was attached by this experimenter to this point; as it appeared that much higher exhaustion was thereby attained.

In 1882, Hannay† proposed to replace the mercury by a fusible alloy of lead, bismuth, and tin, melting at 94°; by this means it was thought that the necessary imperfections

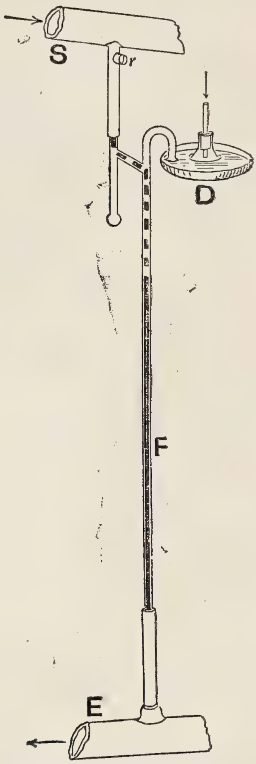
* O. N. Rood. "Sillim. Journ." xx., 57, 1880; *ib.* xxii, 90, 1881. See also *New York Times*, Nov. 19, 1880.

† Hannay. "Philos. Magaz." [5] xiii., 229. 1882.

arising from the pressure of mercury-vapour would be avoided.

The Sprengel pump employed by the Edison Company (New York, 1885) in the manufacture of glow-lamps, has a simple fall-tube cemented (as shown in Fig. 25) at its lower

FIG. 25.



EDISON PUMP (1885).

end into an iron tube, E, which carries away the ejected air and mercury from a series of such pumps. An iron supply-pipe overhead feeds the pumps. Strong sulphuric acid placed in a shallow glass vessel, D, is used for drying.

CLASS II*a*.—SHORTENED DOWNWARD-DRIVING PUMPS.

Stearn,* in 1877, working in conjunction with Swan at the problem of perfecting the incandescent lamp, devised a shortened Sprengel pump. It is obvious that the column of mercury in the Sprengel fall-tube stands, during the later stages of exhaustion, at about 76 centimetres' height, simply because the difference of pressure between the space inside the tube and outside it is about equal to one atmosphere. By removing a portion of the external pressure, the fall-tube may be shortened to any desired extent. Accordingly Stearn applied an auxiliary pump, not at the top as Sprengel had done, to accelerate the early stages of exhaustion, but at the bottom; the collecting chamber, K, being for this purpose closed, and put into communication with the auxiliary pump. Stearn's pump has undergone various modifications; in a recent form* there are three fall-tubes of only about 10 inches length, completely enclosed in a partially exhausted chamber. In this pump there are also means provided for carrying up the mercury from the collecting vessel back to an upper supply-vessel by closing certain taps and opening others which admit the atmospheric air. By this means an extremely small quantity of mercury is made to do duty again and again; and the exhaustion is rapid, because with such short fall-tubes there is less liability of the air-bubbles to stick in the fall-tubes. The action of the pump is made automatic by giving a periodic motion to a three-way cock, which puts a lower receiving chamber alternately in connexion with the atmosphere and with the partial vacuum of the auxiliary pump. Stearn has embodied sundry other modifications in patent specifications.†

A compact modification of Stearn's pump has been devised by Mr. Swinburne,‡ who also has tried an inverted Sprengel pump.

The most recent shortened Sprengel pump is that of Dr. W. W. J. Nicol, described before the British Association at Manchester, in 1887. Its arrangements are depicted in Fig. 26. The principle of its automatic action is identical with that of Von Babo, an auxiliary water dropping air-aspirator (not shown in the figure) being employed to draw in air at the aperture, A, regulated by a tap. This air draws up the fallen mercury in drops, through the return tube, Z, on the left, and returns it into the supply chamber, S, at the top, whence it passes downward through a rubber tube, squeezed between the jaws of a regulating pinch-cock, X, and rises through an air-trap, *t*, into the pump-head. The distributor is simply a horizontal glass tube, sealed into the

* Stearn and Swan. "On a new form of Sprengel's Air-pump." Rep. British Association, 1877, p. 43.

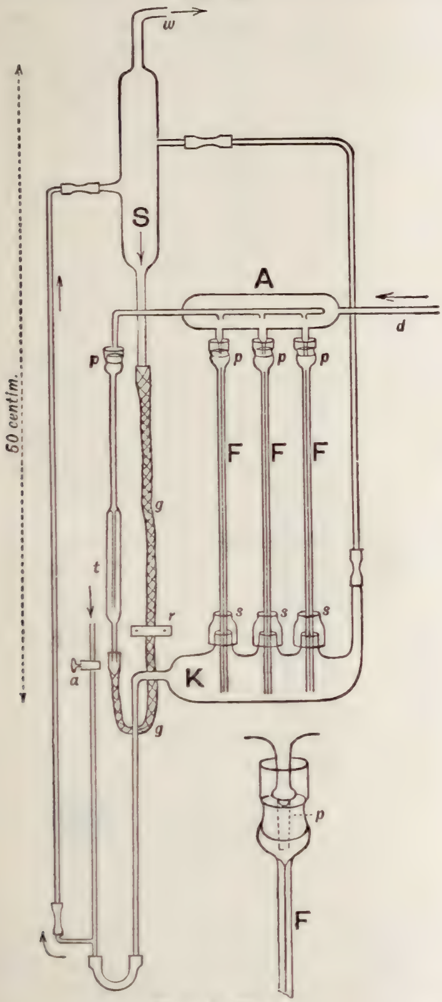
* See Gordon's "Practical Treatise on Electric Lighting," 1884, p. 65, giving an excellent picture.

† Stearn. Specification of patent, 5,000, of 1881. See also Dredge's "Electric Illumination," II. p. ccclxiv. Stearn's shortened Sprengel pumps have been now for several years furnished to the public by Messrs. Mawson & Swan, of Newcastle-on-Tyne.

‡ Swinburne, *Electrician*, xix, 72, 1887.

pump-head, and pierced with small holes above the openings of each fall-tube. (This form of distributor originated independently with Mr. J. T. Bottomley and with Mr. Proctor.) The fall-tubes, F F F, are connected to the pump-head in the following manner. Below the pump-head are sealed, on short pieces of glass, tubing of at least five millimetres bore. These are provided with small flanges, and drawn out conical below, so that

FIG. 26.



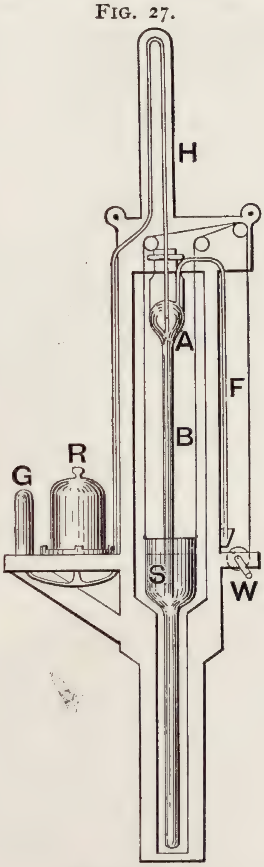
NICOL'S PUMP.

they can be pushed very tightly through small india-rubber plugs, *ppp*, which are firmly fixed in mercury cups. These mercury cups, which are strangulated, so as to nip the rubber plugs, are sealed to the fall-tubes. The lower ends of the fall-tubes pass into the collecting vessel, K, through simple packings, *s s s*, of rubber-tube. The arrows show the course of the mercury. The tube, *d*, leads to the drying apparatus, and to the vessel to be exhausted. This pump can, of course, be used for exhausting only, not for collecting the gas for analysis The entire height of the apparatus is less than one metre. A very small quantity of mercury —only 300 cubic centimetres—is required The entrance of water-vapour at S or *a* is prevented by the use of tubes containing calcium chloride. These pumps are now manufactured for sale by F. Müller, successor to Dr. Geissler, of Bonn.

CLASS III. — UPWARD AND DOWNWARD DRIVING PUMPS.

The earliest example of a pump which drives the air up one barometric column and down another, is the remarkable pump devised by Professor J. Mile,* of Warsaw, in 1828. This pump is described by its inventor as a hydrostatic air-pump without cylinders, taps, lids, or stoppers. The description, as will be seen by Fig. 27, is literally true. The

FIG. 27.



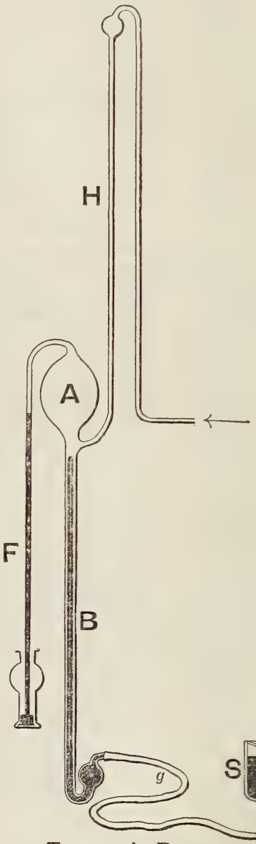
MILE'S PUMP.

* Mile. Neue hydrostatische Luftpumpe ohne Kolben, Haehne, Kappen, und Stöpsel. "Dingler's Polytechnisches Journal," xxx., 1., 1828.

mercury is raised in the barometric tube, B, and pump-head, A, by lifting an external cistern, S, of mercury by means of a winch, W. The rising of the mercury first cuts off communication with the vessel to be exhausted by entering the mouth of the exhaust-tube, which is sealed in through the pump-head; and on further rising it expels the enclosed air through a narrow tube, F, sealed in at the top, which bends over to the right and terminates below in a cup of mercury into which its open end dips. This exit-tube and cup constitute a barometric trap, for when the supply cistern is lowered the air cannot return, the mercury rising in the tube, F, to a height depending upon the degree of internal rarefaction. To prevent the mercury from being forced into the vessel that is to be exhausted, the exhaust tube is prolonged overhead to a height exceeding that of a barometric column. The total height of this pump is, therefore, necessarily, about nine feet. It may be looked upon as a sort of Swedenborg pump, the two valves that open inwardly and outwardly into the pump-head being replaced by barometric air-traps. With such a pump, properly used, a fairly high degree of exhaustion ought to be possible. Strange to say, this pump appears to have fallen into utter oblivion, and its useful features have been several times re-invented.*

The use of a second barometric column, down which the air is expelled from the pump-head, is generally attributed to Professor Toepler,† of Dresden, whose form of pump is shown in Fig. 28. Save in the use of a flexible rubber-tube, and in the manner of bringing the exhaust tube to the lower side of the pump-head, this is identical with Mile's pump. A pump of similar form is sometimes attributed to Mendeleeff; but the writer has been unable to verify the reference. This pump has many of the advantages and disadvantages of the Geissler form of pump. It requires either the tall overhead tube or else an automatic valve. The exit tube, F, is more liable to fracture than any part of the Geissler pump. But, as there are no taps to get out of order, a higher degree of exhaustion can be attained than with any three-way tap arrangement opening into the outer air. There is no need even for any other gauge than the pump itself; for, as Toëpler* has shown, the degree of exhaustion can be measured (as in the McLeod gauge) by raising the mercury in the pump-head to a marked point on the narrow tube just above the pump-head, so as to compress the residual air into the top of the narrow exit-tube, and then reading off the volume and the pressure of the same, and making the required calculations. It possesses this obvious advantage, that the last residua of air in the pump-head are swept

Fig. 28.



Toepler's Pump.

down the tube, F, by the mercury that falls over the bend—"Sprengelised" over, one might almost say. In fact, if it were not the case that this pump antedates Sprengel's, one would be disposed to regard it as a combination of the Geissler and Sprengel pumps.

The Toepler form of pump has received in recent years various modifications. E. Wiedemann† altered the overhead-tube, H, by joining

* See, for example, H. Sutton, in *English Mechanic*, xxxi. 1882, as well as Toepler and Mendeleeff.

† Toepler. Ueber eine einfache Barometer-Luftpumpe ohne Hähne, Ventile, und Schädlichen Raum. "Dingler's Polytechnisches Journal," clxiii. p. 426, 1862.

* Toëpler. "Sitzungsber. d. Naturwiss. Gesellsch. Isis in Dresden," 1877, p. 135. See also Bessel-Hagen, "Wied. Ann." xii., 434, 1881.

† Wiedemann. "Wied. Ann," x., 208, 1880.

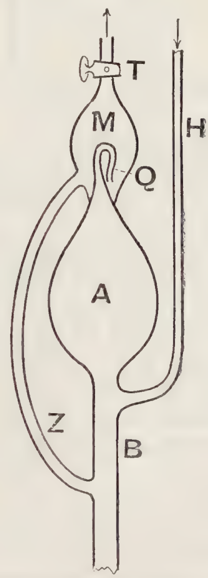
it at its base with two of Gimingham's air-tight joints, allowing it to be removed to be cleaned. Neesen* added the side-tube shown at N in Figs. 18 and 33, to prevent the top of the pump-head being broken off by violent uprushes of mercury in the large bulb. Guglielmo† ingeniously connected the closed top of the collecting vessel (into which the exit-tube discharged air and mercury) with the closed top of the supply vessel, so that as the latter was raised, and the mercury ran out of it, the air-pressure upon the lower end of the barometric column in F was automatically lessened. Improved forms of overhead-tube were suggested by von Helmholtz‡ and by Schuller,§ and a very similar device was used by the writer in 1882 to connect a glow-lamp to the Lane-Fox pump by merely sealing it to the top of a long barometric tube, which slipped on over the top of the open overhead tube—or of a tube connected with it—and dipped into an external ring of mercury in a cup forming a barometric air-tight trap. Neesen|| designed a double-acting pump on this plan, with two pump-heads, and two fall-tubes, the mercury being mechanically driven alternately from one pump to the other by a piston working in a cylinder. The model has not yet been actually constructed.

Other improvements have been made in detail by Couttolene,¶ who drives the air into a partially exhausted space, by Diakonoff,** by Bessel-Hagen,†† and by Karavodine.‡‡ The latter interposes between the top of the pump-head and the exit-tube, F, a small chamber closed at the bottom by a valve consisting only of mercury standing over a capillary orifice, exactly resembling that previously described by Schuller (Fig. 20). This has the result of causing the last portions of residual air to be expelled into a space containing a moderately perfect vacuum. This is a decided improvement. For as was pointed out with respect to the Sprengel pnmp, the air carried down the narrow fall-tube is necessarily compressed in order to drive it down against atmospheric pressure, and bubbles or films remain adherent to the glass.

* Neesen. See below.
† Guglielmo. "Wied. Beibl.," v, 16, 1881.
‡ Von Helmholtz. See Bessel-Hagen, "Wied. Ann.," xii, 429, 1881.
§ Schuller. "Wied. Ann.," xiii., 533, 1881.
|| Neesen. "Wied. Ann.," xi., 522, 1880.
¶ Couttolene. "Comptes Rendus," xci., 920, 1880.
** Diakonoff. See Karavodine.
†† Bessel-Hagen, *loc. cit.*
‡‡ Karavodine. "Journal de Physique," S. II., vol. ii., 558, 1883.

In some modern modifications this is to a very large extent obviated, by the device of so bending the eject-tube or fall-tube, that the air expelled from the pump-head need only descend a very few centimetres down the tube before it enters a chamber that is partially exhausted. In short, if by any device—whether by placing it at the top of a fall-tube or by applying a good mechanical pump—a moderately good exhaustion can be maintained with a chamber such as that marked M, and this chamber is joined to the pump-head by a descending fall-tube, the length of this fall-tube need not exceed the height of a column of mercury representing the difference of pressures between the two chambers. In the diagrams that follow, such a shortened fall-tube is marked Q; it may be regarded as a sort of siphon air-trap. Such an arrangement has been independently devised by several persons. It was patented by Siemens and Halske* in Germany in 1884. Fig. 29 shows

FIG. 29.



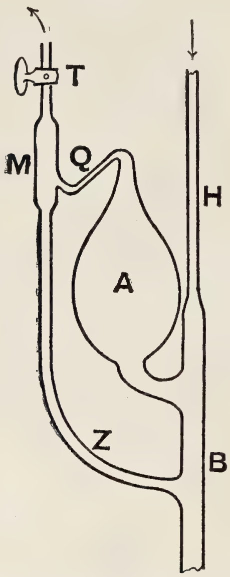
SIEMENS'S PUMP (FIRST FORM).

the device as originally designed. The pump-head terminates in a capillary tube, which turns over into a pool of mercury in the base of the upper chamber, M, into which the residual air is driven with a very slight compression. When a certain amount has thus been collected, it is expelled by further raising the

* Siemens and Halske. D. R. Patent, 28,579, Jan., 1884. For the accompanying sketches of the pumps the writer is indebted to Herr von Hefner Alteneck.

mercury and opening the top tap, T, which is otherwise kept closed. A wider tube, Z, which should be usually closed by a tap, serves to return to the pump shaft the mercury which

FIG. 30.



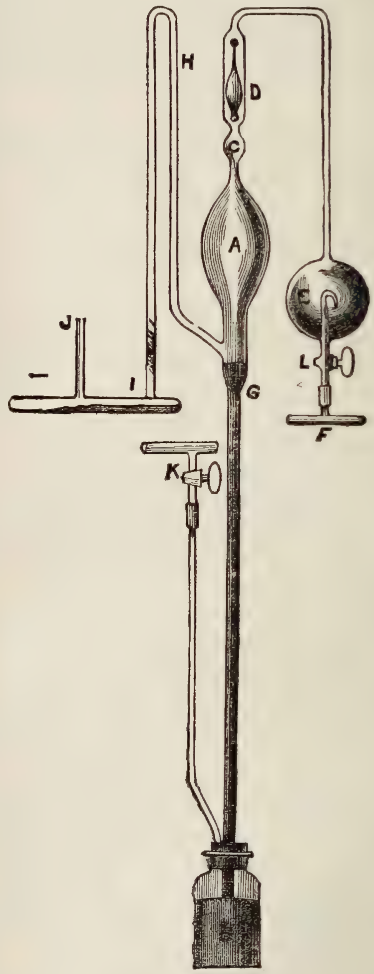
SIEMENS'S PUMP (FACTORY FORM).

may have been driven over into M. A later form of this pump, depicted in Fig. 30, is used in Siemens and Halske's lamp factory in Berlin.

A similar device was suggested by Sundell,* who has further improved the arrangements at the bottom of fall-tube, so as to allow of other gases being admitted to the pump. Some of Neesen's pumps, and that used in the Weston lamp factory in New York, also have this device; but these belong to the sub-class of shortened pumps, and are described below.

Mr. Swinburne,† who has had extensive experience with pumps of several kinds, has described a form in which this principle is applied. Swinburne's first form, though provided, like Toepler's, with a fall-tube, had also an automatic valve above the pump-head. Fig. 31, taken from Swinburne's paper in *The Electrician*, shows this valve situated above a small cavity, C, separated from the pump-head by a constriction, the object of which is to prevent the glass bottom of the valve being broken by the sudden rise of the mercury. The eject chamber, E, is connected through a tap, L, to a horizontal pipe, marked F in this cut. This pipe which runs along a whole range of pumps in the pump-room of the lamp-factory is mechanically exhausted, and the use of the tap, L, is to start the action of

* FIG. 31.



SWINBURNE'S PUMP.

the pumps. After this the action is kept going by a three-way tap (here marked K) which connects the cavity above the mercury in the supply-vessel alternately with the atmosphere and a supply of compressed air. In a later form, Swinburne's pump has a siphon mercury-trap between the pump-head and the automatic valve above it. When the exhaustion has been carried far enough, the mercury is lowered and raised some ten or twenty times, just so

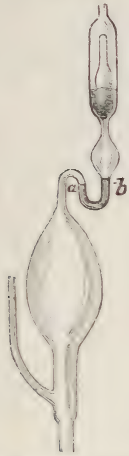
* Sundell. "Wied. Beibl.," ix, 193. 1885.

† Swinburne. "The Electrician," xix., pp. 51, 71, 117, and 158, 1887; a series of papers giving a summary of valuable experience in exhausting glow-lamps.

* This figure is kindly lent by the Editor of *The Electrician.*

far as to drive the residual air through the mercurial syphon, which then will show a small back pressure—perhaps of only one or two centimetres. If the volume of the pump-head is many times as great as that of the cavity beyond the mercury-trap, and if there be a fairly good vacuum beyond the trap, it is obvious that a back pressure of one or two

FIG. 32.



SWINBURNE'S PUMP (LATER FORM).

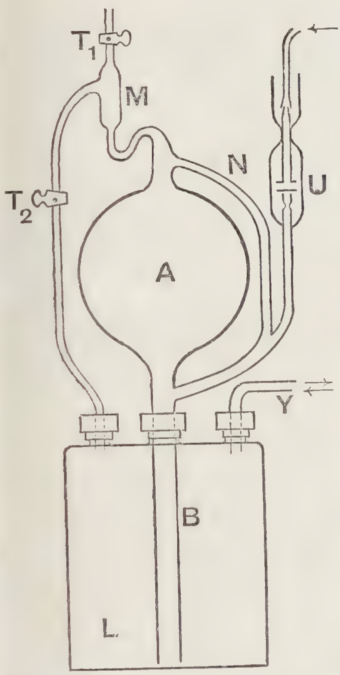
centimetres as the result of twenty strokes may mean a very high degree of exhaustion. Swinburne remarks that the bore of the siphon tub used as a trap must be not larger in the descending part than in the part that ascends to the supplementary chamber.

CLASS IIIA.—SHORTENED UPWARD AND DOWNWARD DRIVING PUMPS.

Swinburne's pump just described might, if worked intermittently with an exhausting instead of a compressing pump, be transferred to the category of shortened pumps.

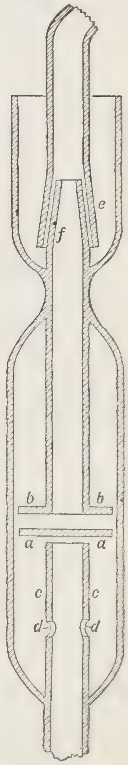
Probably the more perfect of pumps in this class is that of Prof. F. Neesen,* of Berlin. This indefatigable worker has introduced, from time to time, several improvements. As mentioned above, he introduced the side-tube, N, in 1878, and designed a double-acting Toepler pump in 1880. Independently of Mitscherlich, he introduced the automatic valve above the pump-head. In 1882 he was already employing the recurved siphon trap, Q, between the pump-head and the second chamber, M. His complete pump, as constructed in 1887, is shown in Fig. 33. The lower portion is constructed on Robinson's plan, air-tight connections being formed at the three necks of the bottle, L, by the use of coned steel collars, that are cemented to the three tubes, and fit to coned adapters, cemented to the three necks. Steel screw caps clamp down the conical collars into their respective seats. The tube, Y, is put into alternate communication with the atmosphere, and with a good mechanical air-pump, so as to raise and lower the mercury

FIG. 33.



NEESEN'S PUMP.

FIG. 34.



FORM OF 1887.

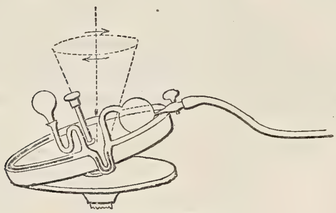
alternately in the pump-head, A. There is an automatic valve, U, in the exhaust-tube, which leads up to the drying flask and to the lamp or other vessel that is to be exhausted. This valve, which is shown enlarged in Fig. 34, is made somewhat on the plan of Schuller, described above, with a small glass disk about two centimetres in diameter, cut from thin plate-glass, which, as the mercury rises under it, is pressed up against a flat flange, fashioned on the lower end of the upper tube. It works in a manner that leaves nothing to be desired.

* Neesen. "Wied. Ann," iii., 608, 1878; *ib.*, xi., 522, 1880; *ib.*, xiii., 384, 1881; "Zeitschr. für Instrumentenkunde," ii., 287, 1882; *ib.*, iii., 245, 1883; also, "Wied. Beibl.," vii, 651, 1883. Figs. 33 and 34 are from sketches kindly furnished by Prof. Neesen.

This pump is further provided with a chamher, M, and a siphon-trap, Q, down which the residual air from the pump-head is expelled into a moderately perfect vacuum.

Another very interesting and extraordinary pump belonging to this class is that of P. Clerc, depicted in Fig. 35. The apparatus

FIG. 35.

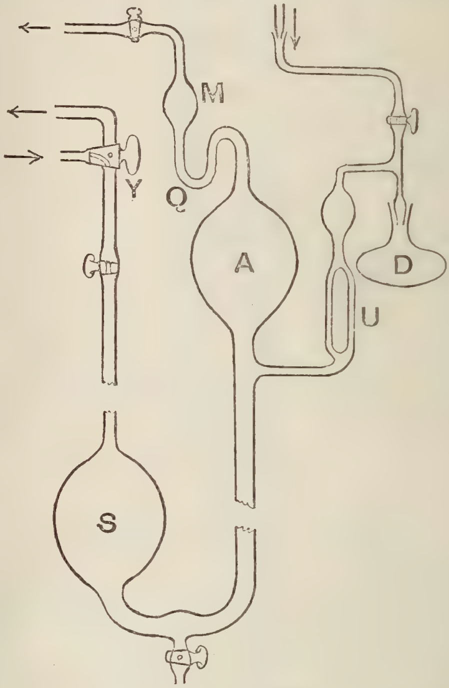


CLERC'S PUMP.

hown is connected by a flexible rubber tube to a mechanical pump capable of giving a moderately perfect vacuum. The apparatus consists of a disc of wood, round the periphery of which is fixed a glass tube, closed in itself, but provided with a U-shaped bend to serve as an air-trap. At one side of this trap rises a short branch tube to which the lamp that is to be exhausted is sealed; at the other a similar branch tube leads to a bulb connected through a tap to the auxiliary pump. Enough mercury is placed in the tube to occupy about a quarter of the circumference and fill the trap. The whole apparatus is mounted obliquely upon another disc of wood, in such a way that it can be rolled round on its periphery by means of a projecting central handle. A preliminary exhaustion having been attained, the tap is closed and the apparatus is rolled around. The mercury in the tube sweeps the air before it into the bulb, and, passing into the trap again, emerges to push a fresh quantity from the lamp in front of it, leaving behind every time in the trap a sufficient quantity of mercury to balance the difference of pressure between the bulb and the lamp. The quantity of mercury required for this apparatus cannot exceed a few cubic centimetres at the most.

Fig. 36† represents the pump used in the lamp factory of Mr. Weston, at Newark, New Jersey. The second chamber, M, connected with the pump-head by the syphon-tube, Q, will at once be recognised, as also the automatic valve, U, in the exhaust tube. The mercury in the supply-vessel, S, is raised and lowered by alternately connecting the upper part of the vessel through the three-way tap, Y, with a mechanical exhaust pump, and with the atmosphere. The top tap is only used when the chamber, M, has to be put into

FIG. 36.



WESTON'S PUMP.

communication with the mechanical pump; the other taps are safety taps, not used during the working of the pump. The tap between the lamps and the valve, U, is worse than useless.

CLASS IV.—COMBINATION PUMPS.

It has been suggested by Edison* and by Böhm† to combine a Geissler pump with a Sprengel pump in the endeavour to obtain a more perfect result. This method of combination, which consists merely in sealing the exhaust tubes of each pump together and to the lamp, cannot be commended. If the Geissler exhausts more perfectly than the Sprengel, or *vice versa*, then the other pump is useless. A much more hopeful combination

* Clerc. "Dingler's Polytechnisches Journal," cclxii., Part II., 1886; also "Zeitschrift für Instrumentenkunde," vi, 403, 1886; and D. R. P. 36447 of 1885.

† For this sketch the writer is indebted to Prof. G. Forbe s

* Edison. "Scribner's Monthly Magazine," Feb. 1880, p. 538; "English Mechanic," xxxii. 117, 1880; see also Urbanitzsky, "Das Elektrische Licht", 1883, p. 56.

† Böhm. See Merling's "Elektrische Beleuchtung," p. 394, or Urbanitsky, *op. cit.* p. 63.

has been suggested by Mr. J. T. Bottomley,* who proposes to utilise a Geissler arrangement to exhaust the chamber into which the foot of the fall-tube of the Sprengel is led, thus putting the two pumps into series.

Class V.—Injector Pumps.

There are a few pumps depending for their action upon the principle of the injector, the degree to which they exhaust depending upon the velocity of efflux of mercury from an orifice, as in the original injector of Hauksbee. The earliest of these were designed by Cavarra† and Plateau.‡ Another form, exhibited in 1876 at South Kensington, was invented by Prof. von Feilitzsch,§ in which two cylinders, fitted with pistons, worked by cranks, drove a mercury blast through suitable jets and drew in air, so creating a vacuum. It exhausted down to a pressure of 1 millimetre, or about 1,300 millionths of an atmosphere.

Several other injection pumps of the centrifugal species were described by de Romilly‖ in 1881, one of them being designated as a *pneole*. Nothing is known to the writer as to its performance.

Class VI.—Mechanical Mercurial Pumps.

Only one pump is known to the writer as coming definitely within this category; and this is a pump designed and constructed by Mr. J. Wimshurst, and of which no account has hitherto been published. It consists of an endless chain of little steel buckets, which pass up one barometric column and down another, within steel tubes containing mercury. Below, they enter a mercury bath, where they pass under two square pulleys, rising over a higher driving pulley between the two. The buckets as they descend, mouth-downwards, carry down air from above the top of the barometric column, and discharge themselves as they come up in the mercury bath. Owing to the fact that it has hitherto been found necessary to employ oil as a lubricant, the power of this highly ingenious apparatus to produce a vacuum is limited.

There are a few pumps concerning which the writer has not been able to obtain information, including those of Diakonoff, Neveux, Pfluger, and Southby, which are known to him by name only.

Results.

The results that have so far been obtained by various pumps may be briefly tabulated as follows: the vacua produced being specified both in millimetres and in millionths of one atmosphere.

If Rood's method of measurement be correct, the results attained by him are very remarkable.

Authority.	Nature of Pump.	Pressure in Millimetres of Mercury.	Pressure in millionths of one atmosphere.
Crookes..........	Improved Sprengel (maximum result)	0·000 046	$\frac{1}{17}$
Gimingham	Single-fall Sprengel, 1·1 millim. diam.	0·000 51	$\frac{2}{3}$
,, ...	Five-fall Sprengel	0·000 006	$\frac{1}{125}$
Rood............	Plain Sprengel	0·000 152	$\frac{1}{5}$
,, ...	Rood's Sprengel, heated	0·000 002	$\frac{1}{388}$
Bessel-Hagen	Old Geissler, after 25 strokes	0·110	145
,, ...	New Geissler (2 taps), after ditto (average)	0·008 5	11
,, ...	,, ,, (maximum result)	0·008 2	$10\frac{1}{2}$
,, ...	Old Toepler, after five strokes................	0·007 5	10
,, ...	,, after five more.................	0·006 4	8
,, ...	Modified Toepler (average)	0·000 012	$\frac{1}{63}$
,, ...	,, ,, (maximum result)	0·000 008	$\frac{1}{95}$

* Bottomley. "Rep. Brit. Assoc.," 1886, Birmingham Meeting, p. 519.

† Cavarra. "Comptes Rendus." 1843.

‡ Plateau. Hervorbringung eines Vacuums mittelst der Centrifugalkraft des Quecksilbers. "Pogg. Ann." 151. 1843.

§ Von Feilitzsch. Theorie und Construction einer hydrodynamischen Luftpumpe. Greifswald, 1876. See also "Mitth. des naturwiss. Ver. v. Neupommern und Rügen," ix., 1877; and Catalogue of Loan Collection of Scientific Apparatus (1876), p. 134.

‖ F. de Romilly. "Journal de Physique," Ser. 1, vol. x., 303, 1881; Ser. 2, vol. iv., 366, 1885.

Conclusion.

On comparing the experience of various workers, it seems as if the best class of pump for the production of such vacua as are required for lamps is the third class, as modified so as to drive the air up the pump-head and down a simple short barometric trap into an already partially exhausted chamber. No one appears to have yet tried a shortened Sprengel with a crook in the fall-tube. The writer offers it as a suggestion. Further, if the experiments of Rood are worth anything, they indicate that an immense advantage is gained by working with pumps heated up above the boiling point of water. The "adsorption" of gases and vapours against the surfaces of glass and mercury in the working parts of the pump is certainly much less hot than cold. Why should not all pumps be so constructed as to enable this method to be adopted? Since much seems to depend on the point of mercury, why should not the mercury be distilled direct into the pump? Whenever cements are used, why should not some plastic inorganic substance, such as chloride of lead or tungstate of lead, be employed, instead of resin, pitch, or other organic body, which will give off vapours? Lastly, if the device of exhausting into an already fairly well exhausted chamber so greatly improves the degree of rarefaction attainable, why should we not carry this process one or two stages further, and relay a series of pumps one working into the other? Such a process would resemble those processes of successive operations which have been called "Pattinsonisation;" and it is possible that it might yield results surpassing anything yet attained.

In surveying the literature of the mercurial air-pump one cannot but be struck with the immense number of workers who have contributed to the invention, and the number of details that have been independently re-invented by different individuals. The literature of the mercurial pump affords, indeed, a striking proof of the fact that inventions grow rather than are made. The invention is essentially the product of the age in which it appears, a necessary consequence of the inventions and discoveries that have preceded it. The scientific method of investigating historical events has shown us how false, how childish, is the "great man" theory of history, which was taught—and alas! is taught still—to us at school. But if the great man theory of history is fallacious, so is also the great man theory of inventions. There were steam-engines before Watt, locomotives before Stephenson, telegraphs before Wheatstone, telephones before Bell, gas-engines before Otto. It may be that occasionally an inventor strikes upon a valuable or useful improvement; it is exceedingly rare for an absolutely original invention to be sufficiently perfect to be of immediate use. Of the essential insufficiency of the great man theory of inventions, the literature of the mercurial air-pump affords a most striking proof.

The investigation of this literature, which has long occupied the writer, has been a fascinating pursuit, partly because of its unexpected richness, partly on account of the fascination of the subject. Every one who has worked with mercurial air-pumps must acknowledge to a kind of fascination in watching the ebb and flow of the liquid metal, and in speculating on the nature of the actions that go on in the vacuous spaces. It was, perhaps, with some such sense that Hauksbee, after describing one of his physico-mechanical experiments, wrote these words:—"Such a dense and polite Body is Mercury; such a subtile Mover is Air; and such an apt Repository is an Exhausted Receiver."

DISCUSSION.

The Chairman said he had listened with great pleasure to this most interesting paper; before he came into the room he thought that he knew something about the mercurial air-pump, but his only feeling now was how much there was still to be known. His name had been mentioned in connection with high vacua, but he must say that his idea of a vacuum varied very much as the work went on. In his early days, when they worked by mechanical means alone, an exhaustion of a millimetre was looked upon as very good indeed, and a little beyond that would have been thought almost a perfect vacuum. Then Sprengel's pump was introduced, and with this we easily got the barometer gauge and the barometer itself level, and that was then called a perfect vacuum. Then the apparatus was used for the various physical experiments which enabled them to detect the pressure of residual air, and the vacuum was in this way seen to be very imperfect. Then chemical means were employed, such as filling the tube with carbonic acid and absorbing by potash. Then those taps which figured in nearly all the pumps had to be done away with, for no good could be obtained if there was a tap or a lubricant. When all this was effected, as in the best form of Sprengel, the vacuum suddenly improved, until it would not conduct electricity. Finally, by

McLeod's gauge, with the modification of Gimingham, we could actually measure the vacuum, and then we found we had what was scarcely worth calling a vacuum at all. The best he had ever succeeded in getting was the one hundredth of a millionth of an atmosphere, which was equivalent to one-tenth of an inch at the top of a barometer tube 200 miles in height. That sounded like a very good vacuum, but when a small tube containing a centimetre of air was exhausted to that extent, there would still be left in it ten billion molecules. The nearer they got to perfection, the farther off it seemed, and the more hopeless it appeared to think of getting a perfect vacuum by any available means.

Mr. J. SWINBURNE, referring to the relative advantages of the long and short Sprengel pump, said he had tried a good many of each, and he must say he preferred the long one. The short one looked better on the table, but the advantage was more apparent than real. If any air got taken down a certain part of the shaft, say six inches, it was safe enough, and never got back again if the pump worked properly. The chief disadvantage to the short shaft arrangement, was the difficulty of preserving a mechanical vacuum. Those he had to do with in commercial work he had found very troublesome, and he would never use one in lamp manufacturing if he could help it. He preferred to use a long shaft with air pressure to lift the mercury. He should like to know the Chairman's opinion as to the measuring of these vacua, because the figures given seemed to him purely fancy figures, and reminded him of the candle-power of arc lamps. In the first place, the McLeod gauge must have some mercurial vapour in it; he did not know whether the tension of that had been accurately determined, but, according to Regnault, it was about 50 millionths, and if that was so, it was absurd to talk of getting a vacuum anything below that. The next point which was put was the way in which air, gas, or vapour seemed to flatten out against the glass. You might have what seemed to be a good vacuum; when mercury was let into it slowly, it would show a bubble, but if admitted quickly would go right up with a smack, and there would be nothing visible at all. In opening bulbs or lamps under mercury, considerable care must be taken, and then many would fill completely with mercury, which would mean a perfect vacuum. Of course, if the McLeod gauge was worked like that, it showed there was something deceptive. Again, taking several lamps off the same pump, and testing them, it would be found that different results were obtained both with coils and opening them under mercury. A good Geissler pump was its own gauge. Referring to the drawings of his own pump, which had been described by Professor Thompson, in which there was a bend, Q, and a little chamber, M, with a valve at the top, he said he had never used it commercially, for it was a far better pump than was needed for that purpose. The object of the bend and the chamber was to meet the point which had been urged; all the pumps shown exhausted into a moderately good vacuum, but that little pump exhausted into a vacuum which was as perfect as any of the other pumps could produce. The vacuum in M was as perfect as it was in A in the other pumps. By exhausting into the little chamber M, and taking, say, 20 strokes, you could get a vacuum to as many millionths as you felt inclined, but about the accuracy of all such measurements he was sceptical. In the first place, if it could be depended on, the vacuum would increase in geometrical progression, but if you worked to any point you liked, and then left it for two hours and came back, you found quite a different state of things. Mercury vapour gave very different effects when tested with a coil and in other ways. In such a pump as that, it seemed impervious to a spark until it was put in connection with a lamp, and then immediately there was a green phosphoresence under ordinary circumstances. That seemed to show that mercury vapour was a non-conductor, unless some air was mixed with it. He believed that had been discovered at the beginning of the century. He had always followed the practice of distilling the mercury, because when it was once put into one of these pumps it lasted until the pump was broken. Silicate of soda was a good cement, and got perfectly hard. He did not know whether he had mentioned, in the paper he sent to the *Electrician*, that he had tried the same system of elevation as Nicol, except that the three shafts were all joined together in one piece, instead of being joined with india-rubber. But there was a great difficulty in regulating the flow of air, and if by any means it went wrong, the mercury got into the phosphoric acid tubes, and into the lamps. As to the relative merits of the Sprengel and the Geissler, the general idea was that the Geissler did to rough out with, and the Sprengel to finish the exhaustion. He should prefer to use a Sprengel for roughing out, if it would do it, but he always finished with a Geissler. He used the form shown on the diagram, with the siphon bend and second chamber, and in making comparative tests he had always found that the Sprengel stopped working long before the Geissler.

Professor W. RAMSAY said Professor Thompson deserved the greatest credit for having brought together sound valuable information. With regard to the McLeod gauge, he thought it possible that some of the air really flattened itself against the glass, or, perhaps more correctly, adhered to it, and formed a sort of condensed gaseous film, so that the ultimate amount measured was not the actual amount in the bulb, but only a small fraction of it. It was quite certain that if the temperature were not kept quite even, a correct measurement could not be made. As a practical point in connection with the cleaning of Sprengel pumps, he would recommend

the use of glacial acetic acid, which had such a high vapour pressure that it removed itself. Even with the cleanest mercury one got films of oxide formed, and in the Sprengel pump, where the little drops fell, there was always a film of oxide formed. This was readily dissolved with glacial acetic acid, and another advantage connected with its use was that you need not pour it in, you only need attach a vessel containing it to the apparatus, and the vapour would pass over in sufficient quantity to clean the pump.

Mr. R. P. SELLON said there was one point worth notice, which Mr. Swinburne had already touched upon. When you tested the vacuum of a glow-lamp by opening a globe under mercury, you sometimes got a very different result from that which you obtained by testing with a Ruhmkorff coil. That was probably due to the fact that the residual air in the globe, broken under mercury, became condensed, and flattened out against the sides of the globe, and thus escaped detection.

Mr. C. V. BOYS said he had not done much with mercurial air-pumps, but he remembered when Prof. Rood's form was described making one, and testing it with a McLeod gauge. The special points about it were the heating, the crook, and another point which had not been referred to. As to the crook, there was no doubt that a small quantity of air always stuck round the upper end of the column, that was swung over and caught on the lower side of the crook, and he was satisfied that was a good thing. The effect of heating was most remarkable; he kept the apparatus so hot that he could not touch it, and the first visible effect was that the reflection of the mercury in the tube was much brighter, as if it were more intimately in contact with the glass; in fact, the film of air which undoubtedly sometimes existed was to a great extent squeezed out. The other point was this: that the mercury, according to Professor Rood's instructions, was not fed into the top of the pump, as in all others of the Sprengel type, but was allowed to fall in a small stream through a bulb. When it began to work, the bulb was entirely filled with mercury, and the equator of the bulb was beneath the level of the fall-pipe. As soon as the vacuum began to get pretty good in the fall-tube, the mercury in the tube fell, and there was above it a very good and very hot vacuum. Then the mercury, in an exceedingly fine stream, was delivered through that vacuum hot, and gave up there any entangled air and moisture, and fell into the space below in as good a condition as mercury could be. He tried one of these pumps with a McLeod gauge. In a hot pump, when there was no crook, the hammering noise was enormously greater. Of course, this hammering, owing to the vibration which ensued, allowed a minute quantity of the air which was carried down to escape back again. The introduction of the crook stopped the hammering, and, of course, prevented the escape of air. There was no reason why people should not always use distilled mercury. Clark's apparatus was very simple, and you could, at a push, distil as much as 14 lbs. per day with it, which would probably be sufficient for all commercial purposes. He was sorry Professor Thompson had not said more about the centrifugal form of pump. About ten years ago he had an idea that it would work very well, and set about making one, 6 in. high and 6 in. in diameter. What corresponded to the fall-tube in a Sprengel pump were radial arms with the ends curved in, and he was in hopes it would work well, but the result was it did not work at all; he did not get more than about a foot of vacuum altogether. He believed the reason was the shape of the radial tubes, and that if, instead of being straight they had been curved like a turbine, the pump would have worked. However, he did not care to undertake making such a thing in glass, and let the matter drop. He had heard considerable doubts expressed whether the figures of the McLeod gauge represented what was supposed. As to the flattening of a minute trace of residual gas between the mercury and the glass, although that will happen when the mercury was let into a bulb, he fancied that under the circumstances in which it was used in the gauge, the mercury slowly rising, with a large expanse above it, would allow the residual gases to rise until they were caught in the small tube, and then there would be such a small surface of mercury that there would not be much room for error on this account.

Mr. W. M. MORDEY said he felt much indebted to Professor Thompson for pointing out so clearly where to go for information on this matter. With regard to paraffin wax as a cement, he might say that about nine years ago he made a barometer of rather thick glass, and happened to break the end in sealing it. He simply dipped it in paraffin wax and filled it up in the usual way, and it had worked quite well ever since. He quite agreed with Professor Thompson's theory as to invention. He believed an inventor was one who, in ninety-nine cases out of the hundred, gave audible voice to whispers that were in the air.

Mr. BOYS said he had found a mixture of pitch and gutta-percha make an excellent cement; but of course no organic compound would compare with sealed glass.

Professor THOMPSON, in reply, said Professor Rood gave a recipe for cement, consisting of 96 parts of Burgundy pitch and 4 of gutta-percha. There was a very convenient form of mercury distiller now available, much simpler than Clarke's, and one which any amateur could easily make with two pieces of barometer tube; it was described by Nebel, and he would put a rough sketch of it on the board. Sulphuric acid would remove itself as well as glacial acetic acid, though not perhaps so quickly. He had hoped that Prof. Ramsay could have given from his own researches some more precise figures than Régnault

as to the vapour pressure of mercury. Régnault gave it at about 20 millionths of an atmosphere at the freezing point.

Professor RAMSEY said that should be divided by about 200.

Professor THOMPSON said Bessel-Hagen gave it as 26 millionths at 20° C., and H. Hertz at about 17 millionths. In the figures Bessel-Hagen gave, he distinctly stated that he subtracted from the observed result in the gauge (which was simply the top of a Toepler pump) 26 millionths as the supposed pressure of mercury vapour, and assumed that the remainder represented the pressure of the residual air. That answered the point which Mr. Swinburne had raised. Bessel-Hagen made exactly the same remark as Mr. Swinburne, as to the Geissler pump going on extracting the air longer than the Sprengel. There was no doubt that air pressing upon mercury or glass did adhere to the surface; that was one reason why, exhausting from a chamber in which there already had been made a moderately good vacuum, you got a much better result. The mercury was then returned into the pump without having had any great air-pressure put upon it. For that reason he differed from Mr. Swinburne as to the use of air-pressure to lift the mercury. No doubt he was correct in saying it was difficult to get workmen to make a satisfactory mechanical apparatus; plumbers did not know very well how to make tubes air-tight, and to make them vacuum-tight was still more difficult, but he did not see why a mechanical difference of this kind should be allowed to stand in the way if the pump would work better when the mercury was never exposed in any part of its journey to the ordinary pressure of the atmosphere, but only worked from a moderately good vacuum to a more perfect one. For this reason he had emphasised the peculiarities of the later forms of pump, which exhausted only between one stage of vacuum and another.

The CHAIRMAN, in proposing a vote of thanks to Professor Thompson, said McLeod's gauge was no doubt imperfect, but it had been found that by taking certain precautions the indications could be relied on, within a certain margin, very well indeed. For instance, the mercury must be squirted into the pump through as good a vacuum as the pump had up to that point reached, and the surrouuding vacuum would take all the air from the surface of the mercury, so that it entered the pump freed from air-films. The pump and everything connected with it must be heated to as high a point as was safe for some time before trying to get a measure of these high vacua. It was true the measurement was only that of the residual air, not of mercury vapour, but that was easily managed. The mercury vapour diffused very slowly through long spiral tubes, and it could easily be kept out by a little device which he published some time ago. By putting between the bulb to be exhausted and the pump a long tube containing in the middle of it a little iodine, and on each side of it powdered sulphur, the mercury would not pass the iodine because it was converted into a solid iodide of mercury. The iodine would not pass the sulphur because it was converted into iodide of sulphur. But the sulphur would, perhaps, get into the pump, and so they put powdered silver outside the sulphur to keep the sulphur out. In that way you might keep the whole mercury vapour out, and the gauge would only show the residual air which was in it. It struck him some time ago what a blessing it would be to physicists if gallium were cheaper; it was a metal which was liquid at 86° Fahr., and would remain liquid at temperatures much below that; it gave off no vapour, and did not oxidise in the air, so that it was an almost perfect metal for a pump of this kind. There was an alloy of gallium and aluminium, which was much lighter, but unfortunately it decomposed in water. There was one point in connection with this paper which specially commended itself to the Society, and that was that without these mercurial pumps we should have had no incandescent electric lighting. Another point was that it had given a new employment to women. Formerly glass-blowing was entirely confined to men, and when he wanted pumps made commercially at first he had to pay £10 or £15 a-piece for them. In connection with some others he started a factory in which the whole glass-blowing was done by girls. It was easy work, just suited for their delicate fingers, and they became as skilful as any of the men. The wages were good, the hours short, and a great deal of work could be done at home. A Sprengel pump, for which he used to give £10 or £15, the girls thought they were handsomely paid for making at 10s. He believed most lamp manufacturers now employed girls to do the glass blowing, for the pumps were always breaking, and had to be repaired on the spot.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

COMMERCIAL EDUCATION.

A Conference, called by the London Chamber of Commerce, was held on Wednesday 23rd inst. at the Cannon-street Hotel, to consider the subject of commercial education; the President of the Chamber, Mr. J. Herbert Tritton, in the chair.

After the meeting had been opened by the chai

man, Sir John Lubbock, M.P., delivered an address in which he said that for 200 years those who have made a study of education have been bewailing the too exclusive devotion to classics, and the neglect of science and modern languages. He believed that the appointment of a Minister of Education would tend strongly to promote the end they had in view, and he concluded by saying that, while desiring to render our school system more practical and useful, he should much regret if it were made less educational or intellectual. He believed, however, that the very reverse will be the case, and that on bringing education more into relation with the practical requirements of life, we shall give it more interest and reality; that boys will feel more conscious of its advantage, and throw themselves into the work with more energy and enthusiasm, will not only be better fitted for their practical duties, but will, in addition, derive even greater advantage from their school life in a purely intellectual point of view.

Sir John Lubbock was followed by Dr. Percival (Head Master of Rugby), Mr. Magniac, Sir Henry Peek, Mr. Mundella, Mr. Frith, and Sir Sydney Waterlow, who addressed the meeting.

On the motion of Sir John Lubbock, seconded by Mr. Mundella, the following resolution was unanimously agreed to:—"That, in the opinion of this meeting, the system of education adopted in the majority of our endowed schools might be modified with great advantage, so as to give more weight to modern languages and science, and that the facilities for acquiring special commercial training are very deficient. That this meeting strongly supports the proposal to appoint a Minister of Education, as recommended by the House of Commons Committee."

It was further resolved, on the motion of Professor Boddington (Yorkshire College of Science), to adjourn the meeting for the consideration of the practical measures it may be advisable to adopt.

DIAMOND CUTTING IN LONDON.

Mr. Lewis Atkinson, manager of the British Diamond Industry, exhibited in the Cape of Good Hope Court, Colonial and Indian Exhibition, has written a letter to *The Times* on the actual extent to which the industry of diamond cutting has already been revived. He writes:—"Nearly 200 years ago Englishmen were the finest diamond cutters in the world, and the trade was nearly all carried on in London, and at the present time old English-cut diamonds will always fetch a very high price, as the cutting is still so much prized. Through religious persecution the cutters migrated to Amsterdam, where they have since remained. At the present time anyone visiting one of the largest diamond cutting factories in Amsterdam will be shown a model of the Koh-i noor, and told that it was cut and finished at their factory, when it is an undisputed fact that both her Majesty the Queen and the late Prince Consort took so great an interest in the cutting, that Messrs. Garrard, the Queen's jewellers, had a room specially fitted up for it to be cut in, and it was all done at Messrs. Garrard's present establishment in the Haymarket. The Duke of Wellington put the first facet on, and her Majesty and nearly all the members of the Royal Family assisted in putting on those most perfect facets that it now has; and there are at least 72 of them on the stone.

"At the time that the African diamond fields were discovered there was only one diamond cutter in London. Dutchmen were accordingly engaged to work in London from Monday morning till Friday sunset, and they were to receive £10 per week each man. There was a very large supply of rough diamonds to be cut, so they struck several times successfully for higher wages. They would allow no person to be in the room that they worked in, being afraid the secrets of their art might be discovered. At last they demanded £18 per week each man, when they were discharged, and English precious gem cutters were put at the work. At first these were only able after a deal of trouble to cut a class of diamond in one month which they could now cut in about four days. As soon as it was clearly proved that Englishmen had once more gained the art, the Worshipful Company of Turners had their attention called to it by their Past Masters, the late Professor Tennant, the Queen's Mineralogist, and Mr. John Jones. They at once decided to give English cutters every encouragement, and have, with the valuable assistance of the Baroness and Mr. Burdett Coutts, who are both members of this company, offered money awards in competition against the Dutch for the best cut diamonds. After several contests the Englishmen gained the first prize and most of the others. Great credit and thanks are due to this company and the Baroness and Mr. Burdett Coutts for giving such valuable assistance to this industry.

"In 1869 there was only one diamond cutter in London, as I have already said. At the taking of the last census the census committee went to a lot of trouble to get the exact number of diamond cutters in London, and I gave them several foreign terms and their meanings that the men might give in describing their trade; but the return was not a success, as a great number of the men put down other trades. They nearly all have some other occupation which they can return to when a depression comes on in the diamond trade, but at the present time there are now a great number actually in full work.

"Up to the end of 1885 out of four of the principal mines of South Africa—viz., Kimberley, De Beers, Bultfontein, and Du Toit's Pan—no less than 33,000,000 carats of diamonds (or more than six-and-a-half tons' weight) have been extracted, realising about £40,000,000. The diamonds now discovered

are nearly all found in British possessions, viz., Africa and India. Mines are now being developed in New South Wales, and yet the vast majority of the stones are still sent to foreign countries to be cut and polished, which, I am sure, every Englishman will consider ought not to be, especially as we have so many good workmen with no employment. With the aid of the British public and the Press, the trade could be developed into a very large and thriving industry, as not only is there an immense opening for men to cut and polish the large stones, but at the present time the supply of small brilliants to use as decorations round other gems, &c., is not equal to the demand. As one of the greatest secrets connected with the trade consists in the one word 'patience,' there is an immense field for the employment of women.

"As a nation the Americans are the finest judges of diamonds in the world. American buyers insist on getting the finest stones and the most perfect of cutting. India takes a very large quantity of the white stones, as the natives invest their capital in them as we do in stocks and shares, but they will not take yellow or coloured diamonds, nor stones with flaws or specks in them. Russia takes the large and yellow stones. China has only lately opened up her country to the diamond trade, as until recently Chinese subjects were not allowed to decorate themselves with these magnificent gems, but just recently the Empress of China has broken through that custom by wearing at Court a very superb diamond necklet, so there is now a demand in that vast continent.

"Where does America go to for her finest cut diamonds? Well, I am thankful to say, London. I believe the last official report published was that America took about £3,000,000 worth of cut diamonds annually from England.

"It is a well known fact that where the British workman has mastered his art, no matter what art that may be, he is absolutely unsurpassed. We are actually at the present time permitting the diamond cutting industry to extend from Amsterdam to Antwerp, New York, and Paris, and even Switzerland is employing large numbers of both male and female workpeople in this art. It only requires a determined effort for us to regain it entirely as our own, and at the present time, I am glad to say, the serious attention of some of our leading men is occupied in trying to develop this industry."

General Notes.

Our Shipping Trade with India.—The official Indian trade returns just received show in detail the entries and clearances at Indian ports, from or to foreign coontries, to have been in the financial year 1881, 12,305 vessels, registering 6,500,000 tons, or an average tonnage of 526 tons. In 1887, 10,581 vessels, total tonnage a little over 7,000,000, or an average of 678 tons, showing an increase in the average tonnage capacity of vessels. Of these, the steamers which entered and cleared last year were 1,620, of 2,398,164 aggregate tonnage. The number and tonnage of steamers, entries and clearances, adopting the Suez Canal route were 1,671, of about 3,000,000 tons.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

November 30.—"Economical Illumination from Waste Oils." By J. B. Hannay. Sir E. A. Inglefield, K.C.B., F.R.S., will preside.

December 7.—"The Chemistry, Commerce, and Uses of Eggs of various kinds." By P. L. Simmonds.

December 14.—"Commercial Education." By Sir Philip Magnus. Sir Douglas Galton, K.C.B., F.R.S., Chairman of Council, will preside.

Papers for the meetings after Christmas:—

"Technical Instruction in Agriculture." By Prof. John Wrightson.

"Machine Tools for Boot and Shoe Manufacture." By John W. Urquhart.

"Framework Knitting." By W. T. Rowlett.

"Locks and Safes." By Samuel Chatwood.

"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S.

"The Measurement of Electricity." By Prof. George Forbes, F.R.S.

"The Continuation of Elementary Education." By W. Lant Carpenter, B.A., B.Sc.

"Type-writers and Type-writing." By John Harrison.

"Methods of Taking the Ballot." Two papers by John Leighton and James Withers.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 17; February 7; March 6, 27; April 17; May 15.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—

January 27; February 10, 24; March 16; April 13; May 4.

Applied Art Section.

The meetings of this Section will take place

on the following Tuesday evenings, at Eight o'clock:—

January 31; February 14; March 20; April 24; May 8, 29.

Cantor Lectures.

The First Course will be on "The Elements of Architectural Design." By H. H. Statham. Four Lectures.

Lecture I.—November 28.—Definition of architecture.—Its range and capability as an art.—Position in relation to other forms of art.—The architectural problem fourfold.—The plan.—The building up.—The covering in.—The decorative treatment.—Methods of delineating an architectural design by geometrical drawings.—Relation of plan to exterior design.—The question of proportion.—Plan in itself a form of artistic expression.—Examples.

Lecture II.—December 5.—Influence of the mode of covering in on the general design.—The two systems of covering spaces, the beam and the arch.—Definition of "style."—Statical conditions of the beam system.—Its architectural expression as worked out by the Greeks.—The column.—The entablature.—The three styles employed by the Greeks.—The superstition of the "Five Orders."—Roman and Renaissance application of Greek forms.—Value of ancient classical forms to modern architecture.

Lecture III.—December 12.—The statical conditions of the arched method of covering.—Distinction between the column and the buttress.—The "waggon" vault.—The dome and domed architecture.—The development of the vault.—Transition from Romanesque to pointed architecture.—Constructive origin of the pointed arch.—Its development into the complete Gothic style.—Comparative analysis of Greek and Gothic styles.

Lecture IV.—December 19.—Architectural decoration.—Of two classes, moulded surfaces and carving.—The function of mouldings in architectural expression.—Their relation to material and climate.—Decorative carving.—Also influenced by material.—Its relation to nature and natural forms.—Applied decoration.—Architecture in cities.—Effective arrangement of sites.—Architecture and landscape.

The Second Course will be on "Yeast, its Morphology and Culture." By A. Gordon Salamon. Four Lectures.

January 30; February 6, 13, 20.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By John Mayall, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor Chandler Roberts-Austen, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By Richard Bannister. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By Walter Crane. Three Lectures.

April 30; May 7, 14.

Juvenile Lectures.

Two Juvenile Lectures on "The Application of Electricity to Lighting and Working," by William Henry Preece, F.R.S., will be given on Wednesday evenings, January 4 and 11, 1888, at Seven o'clock.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 28 SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures). Mr. H. H. Statham, "The Elements of Architectural Design." (Lecture I.).

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. A. D. Carey, "Journey round Chinese Turkestan and along the Northern Frontier of Tibet."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, Nov. 29...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Sir F. A. Abel's paper, "Accidents in Mines."

Wednesday, Nov. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Hannay, "Economical Illumination from Waste Oils."

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

Royal, Burlington-house, W., 4½ p.m.

Thursday, Dec. 1...Linnean, Burlington-house, W., 8 p.m. 1. Sir J. Lubbock, "Ants, Bees, and Wasps." (Part II.) 2. Mr. R. J. Pocock, "Myriopoda of Mergui Archipelago."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Dunstan and Mr. T. S. Dymond, "On the supposed Nitroethane." 2. Prof. H. E. Armstrong, "Researches on the laws of substitution in the Napthaline Series."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Archæological Institution, Oxford-mansions, Oxford-street, W., 4 p.m.

Friday, Dec. 2...Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Mr. A. Wharton Metcalfe, "The Classification of Continuous Railway Brakes."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Mr. H. Bradley, "English Etymologies:—Cesspool, &c."

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FRIDAY, DECEMBER 2, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Tuesday, 29th November, at 4 p.m. Present:—Sir George Birdwood, K.C.I.E., M.D., LL.D., C.S.I., in the chair; Mr. Hyde Clarke; Sir Douglas Galton, K.C.B., Major-General Sir Frederick J. Goldsmid, K.C.S.I., C.B.; Colonel Sir Owen Burne, K.C.S.I.; with Mr. H. Trueman Wood, Secretary of the Society; and Mr. Demetrius Boulger, Secretary of the Section. The programme of papers to be read during the present Session was discussed.

APPLIED ART SECTION.

A meeting of the Committee of the Section of Applied Art was held on Monday, 28th November, at 4 p.m. Present:—Sir George Birdwood, K.C.I.E., M.D., LL.D., C.S.I., in the chair; Mr. Walter Crane; Mr. Lewis F. Day; Sir T. Villiers Lister, K.C.M.G.; Mr. Vincent Robinson; Mr. W. Simpson; Mr. R. Phené Spiers; and Mr. T. Wardle; with Mr. H. Trueman Wood, Secretary of the Society; and Mr. Henry B. Wheatley, Secretary of the Section. The programme of papers to be read during the present Session was discussed.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for October 28th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, November 30th, 1887; Sir Juland Danvers, K.C.S.I., in the chair.

The following candidates were proposed for election as members of the Society:—

Adam, Alexander Learmouth, 40, Sir Michael-street, Greenock.
Albright, William Arthur, Mariémont, Birmingham.
Burne, Colonel Sir Owen Tudor, K.C.S.I., C.I.E., India-office, S.W., and 57, Sutherland-avenue, W.
Collard, Charles, The Brewery, Park-street, Southwark, S.E.
Glossop, William Dale, 1, Whitehall-gardens, S.W.
Hirst, Hugh Taylor, Ladcastle, Dobcross, Oldham, Lancashire.
Jowett, William, Lower-hall, Mellor, Stockport.
Krabbé, Charles Henry, Woodcote, 16, Clive-road, West Hampstead, N.W., and Buenos Ayres, South America.
Tasker, John, Crookes-house, Sheffield.
Thompson, William Thomas, Frog Island Mills, Leicester.
Vaulin, Claude Theodore James, 23, Old Jewry, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Ainge, Thomas Styles, Municipal-buildings, Liverpool.
Anderson, John, Town-hall, Montrose, N.B.
Anstruther, Lieut. Sir Ralph William, Bart., R.E., South Camp, Aldershot, and Balcaskie, Pittenweem, N.B.
Aulagnier, Louis E., 27, King-street, Covent-garden, W.C.
Bailey, Frank, Electric Light Works, Westbourne-bridge, Paddington, W.
Bapty, Samuel Lee, 36, Manor-road, Brockley, S.E.
Bayley, Edward Hodson, 42, Newington-causeway, S.E.
Bell, John Charles, Langbaurgh-hall, Great Ayton, Yorkshire.

Belton, Charles, Cartlands, Cookham Dean, Berks., and Junior Carlton Club, S.W.
Berry, Ernest Gower, 8, Wardour-street, Soho, W.
Bill, Henry, 155, Fenchurch-street, E.C., and 10, Strathmore-gardens, Kensington, W.
Butler, William Butler, 14, New Burlington-street, W.
Cassell, James Robert, 11, Billiter-square, E.C.
Crewe, Hugo Harpur, Spring-hill, East Cowes, Isle of Wight, and Windham Club, St. James's-square, S.W.
Croft, George C., 6, Stanhope-street, Hyde-park-gardens, W.
Crook, Charles Alexander, Enderby's Wharf, East Greenwich, S.E.
Drake, Bernard Mervyn, 2, Prince's-mansions, Victoria-street, S.W.
Draper, Alfred C. S., 40, Weston-street, Southwark, S.E., and 21, Russell-square, W.C.
Ely, Marquis of, Kearsney Abbey, near Dover, Kent.
Foster, Harry Seymour, Glenhurst, West Dulwich, S.E., and City Carlton Club, E.C.
Foster, William Joseph, 21, Birchin-lane, E.C., and 42, Hogarth-road, South Kensington, S.W.
Fothergill, Joseph, Tynemouth, Northumberland.
Harrison, George Howard, 4, Great George-street, S.W., and Hampton Wick, Surrey.
Hartel, Adolph, The Hermitage, Ravenscourt-park, Hammersmith, W.
Hodgson, James Stewart, 8, Bishopsgate-street Within, E.C.
Holland, Colonel James, Southside, The Park, Upper Norwood, S.E.
Hood, Henry J., M.A., 115, St. George's-road, S.W.
Hopkins, Edward Martin, 3, Upper Berkeley-street, W.
Johnson, Joseph William, Beau Manor, Maidstone.
Jonas, Lewis E., 63 Finchley-road, N.W.
Lees, Samuel, Park-bridge, Ashton-under-Lyne.
Lysons, General Sir Daniel, G.C.B., 22, Warwick-square, S.W.
McGarel-Hogg, Hon. Archibald Campbell, 17, Grosvenor-gardens, S.W.
McGavin, Ebenezer William, 8, Great Winchester-street, E.C.
Mapp, Paul Frederick W., 21, Kensington Park-road, W.
Margetts, William George, 21, Calverley-park, Tunbridge Wells, and St. Stephen's Club, S.W.
Morton, G. H., jun., London-road, Liverpool.
Mukerji, Satya Chandra, M.A., Mathura, N.W.P., India.
Nin, His Excellency Dr. Alberto, 19, Gloucester-place, Portman-square, W.
Norman, Leo J. N., 21, Mincing-lane, E.C., and Junior Travellers' Club, Piccadilly, W.
Owen, Hugh Gwynne, 17, Cavendish-place, W., and Salisbury Club, St. James's-square, S.W.
Oxenham, Edward Lavington, Nutcombe-house, Weybridge, Surrey.
Paine, George William, Cotswold-lodge, Farquhar-road, Upper Norwood, S.E.
Pegler, Oliver, Bledington, near Chipping Norton, Oxon.
Pincott, James, Tellham-house, Brixton-hill, S.W.
Ram, Diwan Doulat, 128, Lancaster-road, Notting-hill, W.
Rankin, William, Tiernaleague, Carndonagh, Co. Donegal.
Rapley, Frederick Harvey, Dashwood-house, 9, New Broad-street, E.C.
Reed, Albert E., 21, St. Andrew's-crescent, Cardiff.
Robinson, Frederick A., 7, Queen Elizabeth's-avenue, Lordship-park, Stoke Newington, N.
Sadler, George, Brooklyn-house, Clapham-road, S.W.
Schroller, William, 2, Belmont-terrace, Dickenson-road, Rusholme, Manchester.
Self, James, M.D., Fairview, Farncombe-road, Worthing.
Silley, Abraham, 17, Craven-street, Strand, W.C.
Skliros, George Eustace, M.A., B.Sc., 291, Regent-street, W.
Smith, Captain John Henderson, R.N.R., H.M.S. *Worcester*, Greenhithe, Kent.
Tamini, Luis B., 5, Copthall-buildings, E.C., and 5, Park-road, Regent's-park, N.W.
Taylor, Robert Henry, Regent-house, Wilson-grove, Southsea.
Thompson, Richard Charles, Woodside, Sunderland.
Waldo-Sibthorp, Colonel Francis Richard, 41, Sillwood-road, Brighton.
Walker, Robert James, Woodside, Leicester.
Wright, John, 120, Malpas-road, Brockley, S.E.

The Chairman apologised for the unavoidable absence, through illness, of Mr. Hannay, and the paper was then read by the Secretary.

ECONOMICAL ILLUMINATION FROM WASTE OILS.

By J. B. Hannay.

It has been said that the fall of Britain from her place among industrial nations will date from the practical exhaustion of her coal-fields, and some prominent writers and economists have actually gone so far as to calculate to within a few years when, in their opinion, this exhaustion will be complete. Now, it appears to me somewhat strange that thoughtful men should have made any such prediction. Surely their eyes must have been closed to that huge factor in modern civilisation—the advance of science. Admitting for the moment the possibility of our coal-beds becoming exhausted sooner or later, it must not be forgotten that there is in the British mind an

illimitable power of invention, an inexhaustible wealth of resource, which, when the emergency arises—and long before it becomes acute—will find some substitute for any substance which may previously have been considered indispensable to the existence of any of the industries that maintain us as the first of commercial countries. When we consider how ignorant we really are of the resources of the earth's crust at any considerable distance from the surface, and that new coal-beds of even greater dimensions than the old ones are being discovered, calculations of the kind referred to appear ridiculous. But it is not of coal that I intend to treat in this paper: I propose to deal with a substance which, as a source of light and fuel, I believe will ultimately render coal of merely secondary importance in our manufactures. That substance is the oil which, in certain parts of the earth's crust, occurs in large quantities, and has in places betrayed its presence by coming to the surface in the form of what have been not improperly termed "springs." One of the oldest trades in the world consisted in collecting this surface oil near the Caspian Sea, and selling it in Persia for the production of light and heat. And it is of some modern developments of this ancient trade that I would speak to-night. I need not here tell the members of this Society of the inexhaustible stores of this oil at Baku, on the Caspian; neither need I allude to the indications, amounting recently to proof, that similar stores exist in nearly every division of the earth's crust, not excepting even New Zealand; nor that railways, steamers, and stationary engines are being run by oil fuel in Russia, India, Egypt, and America, and will soon be running here, as this information has already been given in a masterly manner by Mr. Chas. Marvin, whose patriotic labours merit national recognition.

The proofs are all there that, locked up in the earth's crust, and at no great distance beneath the surface, are enormous reservoirs of oil, the most economical and convenient form of fuel in existence. At present practical men are busy arranging to make this store available for our use in the manifold operations which engineering has established during the century. Pending the opening up of these stores, there are at present ready for use large quantities of waste oil, obtained as a bye-product from some of our great manufacturing industries, the disposal of which was, until recently, a puzzle to chemists and engineers.

In one industry alone—namely, iron smelting—there could be manufactured enormous quantities of crude oil, and even the few furnaces already fitted with condensing apparatus are sending large quantities of oil into commerce at a very remunerative price. I believe it will not be long before every blast furnace will be fitted with its condenser, and thus add to the fertility of the country by securing the vast quantities of ammonia at present lost, and to the resources and wealth of the country by yielding us oil for the production of light and heat.

It is not of the application of oil as a fuel for the great industries that I come here to speak, but of some minor uses to which such fuel is particularly adapted, and which require no revolution in any great industry, but which will aid all industries. I believe such introduction of liquid hydro-carbons for producing light and heat, is but "the thin end of the wedge," and will ultimately lead to its utilisation in the great business of the nation. The attempts which have hitherto been made to obtain light from oil, have led to the belief that no useful light can be had without the aid of an artificial draught. The trouble and care required in managing such lights rendered the introduction of gas—as an illuminant which required no artificial draught—a real boon, and soon the world came to know what a comfort it was to have the house well lit on the long, dark winter nights. Soon the light of the house was used in the workshop; but as operations gained in magnitude, gas was found to be quite unequal to the work demanded of it, and, more especially for out-door operations, the want of a good light began to be keenly felt.

The electric light at first bade fair to supply the want, but soon it was found that its very beauty and intensity were the cause of its uselessness for ordinary workshop operations; and I have often seen a workman at his lathe using the antiquated tallow candle, to appreciate the details of his work, right underneath the dazzling glare of an arc lamp.

Now, the first use of the exhaustless store of oil in the earth's crust, which I am going to illustrate, is its use for yielding a powerful diffused light, for conducting difficult work during the darkness of our short winter days and long winter nights. The fundamental difference between a gas flame and one from oil lies in the fact that the gas contains much less carbon, and when the hydrogen burns there is so little carbon set free that it is completely

burned away to carbonic acid, as it reaches the outer portion of the flame. The greater proportion of carbon in the oil causes the carbon to be set free in a much denser form, and the paucity of hydrogen makes the temperature of the flame lower, and the combination of the carbon is incomplete; hence smoke arises.

To obviate this, artificial draught has been resorted to, by placing a funnel over the flame, and so causing the air to impinge at the root of the flame, or the same effect has been attained, as in the "Empress" lamp, by means of a small fan. When it came to producing large flames, the matter of dealing with the wick and draught became much more difficult, and when a light was wanted for outside purposes, all arrangements with glass funnels were impossible, while such a weak blast as could be used for supplying oxygen to this flame was at once reversed, and the flame extinguished by the slightest breeze of wind. What is required for an open air illumination, unprotected by glass, is such a mixture of hydrocarbon and air as will set free only as much carbon as will be consumed by the time it reaches the edge of the flame, and a flame of such pressure or stiffness as will resist the wind. A type of the first condition is found in those gas producers whose action depends on passing air through some of the volatile hydrocarbons, when the air takes up sufficient vapour to yield the amount of carbon on combustion to give luminosity like coal gas. Yet the bulk of that gas is air. Now, a carburetted air may be closely imitated by intimately mixing finely divided liquid hydrocarbons, or even solid hydrocarbons, with air, the state of division being so fine that the hydrocarbon may be said to be equally distributed throughout the air. When such a mixture is fired, the heat of the initially burning hydrocarbons volatilises the remaining hydrocarbons, and produces that mixture of hydrocarbon vapour and air which closely imitates coal gas. But with this important difference. The blast required to disintegrate the oil is such a powerful one that the flame is rendered very stiff, and resists the deflecting power of the wind, so that the naked flame thoroughly illuminates a space as well during stormy weather as during calm. Now, that is the great desideratum of an outdoor light. Besides this, the amount of air supplied for combustion is in no way dependent on the draught created by the lamp, but can be varied to the most extreme proportions at will, so that such a lamp will burn any kind of hydrocarbon, from the most volatile naphtha to the thick tar, which requires to be warmed to flow. In fact, any of these hydrocarbons may also be burned either so that no free carbon is given off, and hence the flame is non-luminous, like a Bunsen flame, or it may be given less and less oxygen, its luminosity increasing until the point is reached where it begins to give off unburnt carbon, and smoke is produced.

Then such is the force of the escaping mixture of spray and air that the flame may be propelled in any direction, vertically upwards, or downwards, horizontally or slanting, and it takes the direction in which the burner is pointed without the slightest deviation. It will be clear that this flame possesses properties and has a range of adaptability such as are possessed by no other flame; and I propose to illustrate to you in what manner these important properties may be made available for some uses in the arts.

The conditions necessary for the production of light from any hydrocarbon are the presence of just sufficient air for the combustion of so much of the hydrogen and carbon as shall raise the temperature of the residual hydrocarbon to the point of dissociation, so that carbon may be set free in the flame. The carbon so set free glows and radiates both heat and light, and as it passes up through the flame, it must reach the outer edge at such a temperature as will insure its complete combustion in the free air with which it comes in contact. In coal gas, which is poor in carbon, these conditions may be brought about by merely spreading the gas into a thin film, and igniting it, but in oils or hydrocarbon vapours the amount of oxygen thus supplied is too small, and it is necessary to urge a blast of air against the flame to prevent smoke. But there is a class of oils which contain so very much carbon, and are so easily decomposed, that even the heat of the flame at the wick of a lamp will cause them to deposit carbon, and even the best draught produced by a funnel will not bring sufficient oxygen into contact with their flames to prevent smoke. In the case of such oils, the only method of obtaining smokeless flames is by causing the air to mix with the vapour throughout the flame, and, by preference, using hot air. When this is done, a very thick flame may be used, and this constitutes a most important feature of the new method of producing light, which I am about to explain to you.

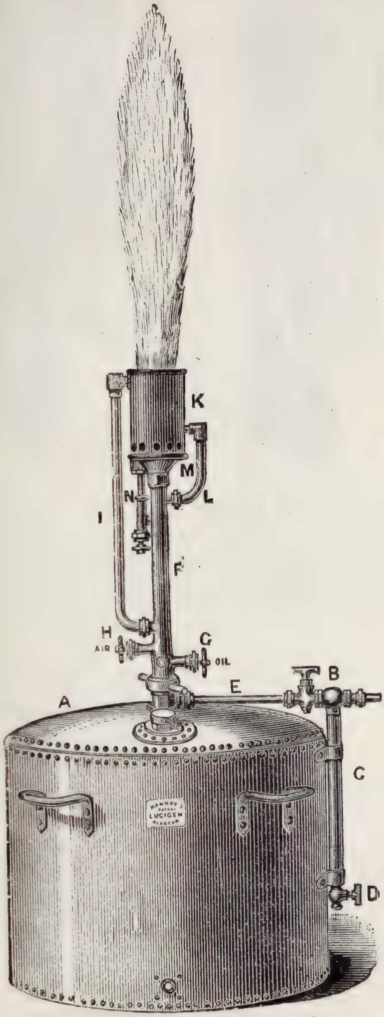
It has been shown that the carbon set free

in a flame is either only a very dense hydrocarbon in the gaseous state, or, what I think much more probable, is carbon in such a molecularly fine state of division that it passes the vibration of light on just as though it were a transparent body, so that the thickness of a flame does not to any extent obstruct the light passing out from its centre. Now, provided that this thickness can be obtained without the production of smoke, it is a very important property of a flame, because each particle of carbon travels for a longer time incandescent, and because a large body of flame can reach a higher temperature than a thin body exposed to cold air. Thus we get not only more light emitted by each particle, but that light is emitted for a longer time.

Now, as to the apparatus for bringing about this result. After a long series of experiments, extending over several years, and involving the construction of very varied forms of apparatus, the inquiry has gradually become narrowed down till a form has been reached which gives all the results that could be expected from the crude hydrocarbons with which we deal, and which yields a beautifully clear light from any oil, up to coal tar as thick as treacle, provided it is free from water.

The common form of the apparatus, which has been called the Lucigen, and which is wrought by compressed air, is illustrated at Fig. 1, and the oil is contained in the tank, A. The supply of compressed air, which should be supplied at a pressure between fifteen and twenty pounds per square inch, is connected to the tap, B. C is a moisture trap, so that any water which might be in the air tubes cannot pass into the oil. In starting the lamp, the small cock, D, is slightly opened to allow any water to run out. The air passes in by the tube, E, and has access to the oil tank, where it presses on the surface of the oil in A, and forces it up the central tube, F, to the burner, the flow being controlled by the valve, G. The supply of air for disintegrating the oil and aiding in combustion passes through the controlling valve, H, and up by the side tube, I, to coil super-heater, K, where it circulates round the flame and gets highly heated. This super-heater also protects the root of the flame from violent gusts of wind when the lamp is used for engineering operations in the open air. The form of this super-heater has been altered many times, but this answers all purposes best. The heated air passes down by the tube, L, and into the burner, where it surrounds the oil tube, and hence warms the oil before it reaches the burner. This is important, as the crude oil thickens in cold weather, and stops the burner. The burner, M, consists of two concentric cones, the inner one containing the oil, and the outer the hot air, and these issue as a spray mixture into the

Fig. 1.



combustion chamber, N. This latter is a most important part of the burner, and is shown enlarged at Fig. 2, a view, and Fig. 3, a section (p. 58). It will be seen that the chamber has three walls, and the air enters through the perforations at the bottom of the outer wall, passes up between the outer and middle wall, and down between the middle and the inner wall, and below the edge of the latter to the flame. The inner chamber is

formed bell-mouthed, in the form of an aspirator, and a powerful draught of air is sucked in and delivered at the root of the flame. The narrow part of the bell-mouthed combustion

FIG. 2.

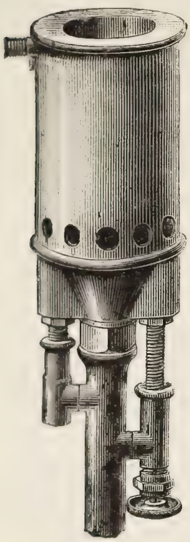
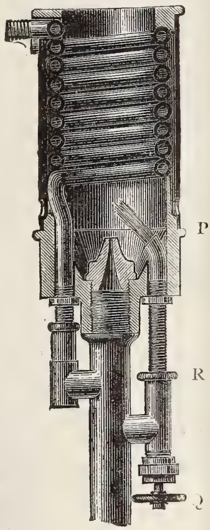
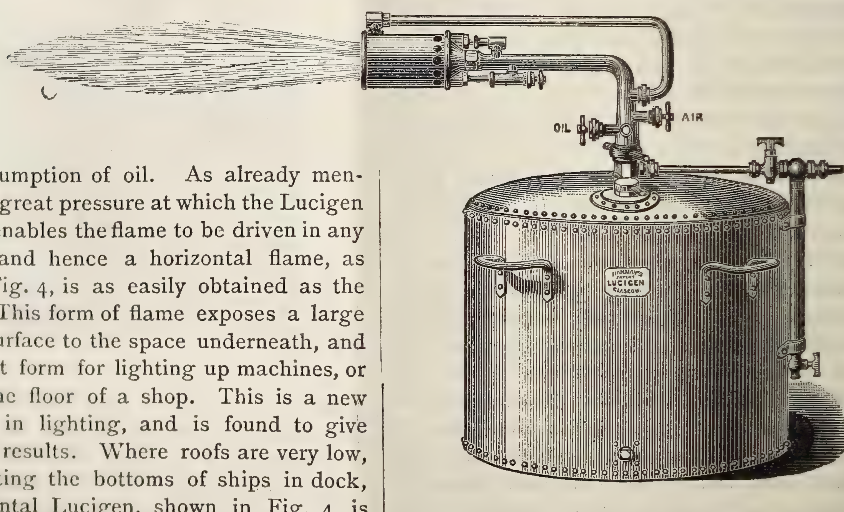


FIG. 3.



chamber soon becomes red hot, and as the form of the chamber leaves a larger space here than at any other part of the course, the air moves slowly here, and has time to get thoroughly heated, so that the form of this chamber serves two purposes. The result is a powerful jet of mixed spray, hot air, and hydrocarbon vapour, driven out by compressed hot air, and surrounded by an aspirated sheet of hot air derived from the atmosphere. When this is ignited, it forms a cylinder of flame, tapering at both ends, about 3 feet long by 9 inches in diameter at its widest part, and of an intense whiteness, without the slightest vestige of smoke or smell. The apparatus above described is suitable for open spaces and workshops where a lateral diffusion of the light is wanted, and modifications of the apparatus have been prepared which enables it to be adapted to almost every kind of building and work. When a local light is wanted for illuminating any machine or small space, a smaller apparatus has been constructed, to yield from 400 to 800 candle-power. This is constructed exactly on the lines of the larger lamp. The form of the flame being that of an elongated cylinder, causes it to radiate much more light, and light of a much more diffusive character, in a direction at right angles to its length than in any other direction; hence when required for lighting a large radius on a level with the flame, the vertical flame is used, but when the light is wanted to illuminate the space underneath a horizontal flame gives much greater duty for the

FIG. 4.



same consumption of oil. As already mentioned, the great pressure at which the Lucigen is worked enables the flame to be driven in any direction, and hence a horizontal flame, as shown in Fig. 4, is as easily obtained as the vertical. This form of flame exposes a large radiated surface to the space underneath, and is the best form for lighting up machines, or work on the floor of a shop. This is a new departure in lighting, and is found to give admirable results. Where roofs are very low, or for lighting the bottoms of ships in dock, the horizontal Lucigen, shown in Fig. 4, is also specially suitable. Sheds only 10 feet high, and with wooden roofs, can be efficiently and safely lighted up by means of this horizontal burner; and as it casts its flame out at about 20 inches from the ground, the bottom of a ship in dry dock can be beautifully lit up by placing one of these lights on the ground on each side of the ship. Where the apparatus is placed against a wall, and intended to light the machinery beneath, while also yielding a

light all round, the flame is given an angular direction, so that no shadows are cast underneath.

When a work has to be lit up permanently, and the separate oil tanks might be in the way, the oil may be kept in a single large tank, which is placed preferably on the same level as the lights, and the oil and air are led separately in tubes to the various burners. The oil in the main tank is placed under the air pressure, and thus acts at the burner just in the same way as it would were it supplied in separate tanks.

Where a large illumination is required to be thrown over an irregular surface, or in a yard where structures are being built, the Lucigen is arranged in triplex form, and the illuminating of each burner is considerably increased by the intense heat this arrangement develops. The total light is from 9,000 to 11,000 candle-power *actual*, and it produces an illumination unapproached by any method of producing light hitherto invented, and only to be compared with a conflagration.

When a number of lights are fitted up in a work, the labour of filling the tanks by pumping is considerable if performed by hand. To obviate this a portable tank has been prepared, which is filled with oil, and wheeled to a position underneath the tank. A tube is led from the bottom of the portable tank to the Lucigen above, and the compressed air is admitted to the top of the portable tank, when the oil is forced up to the tank. In this way the Lucigen may be speedily and easily filled.

The size of the flame given by these lamps is so great that the shadows are all nebulous at the edges, and the volume of light, if I may so call it, is so great that the reflection from surrounding objects lights up the shadows, and prevents that blackness of shadow so troublesome with the electric light; at the same time the flame may be made of any smaller size by simply turning the valves, G and H Fig. 1, so as to cut off more or less oil and air.

The flame cannot be blown out by any wind, because while a strong wind may bend the flame, and a hurricane may scatter it, the formation of the combustion chamber keeps the root of the flame thoroughly protected, so that no wind can extinguish it. But it may happen that, in spite of precautions, the crude oil used contains drops of water, derived, perhaps, from imperfectly drained casks or other causes; and as the class of oils used for the Lucigen are nearly of the same density as water, such drops do not settle, but pass into the burner with the oil. When this happens a gap is caused in the flame, and it is extinguished. In order to prevent such accidents, the arrangement P Q R in Fig. 3 is used to re-light the flame. It consists in an independent supply of oil passing through the connection, R, and regulated by the small screw valve, Q, passing up by a tube to a burner, P, which has a wick composed of asbestos and wire. The amount of oil passed is very small, and the heat is so great that most of it is volatilised, and keeps a small gas flame burning at P, which re-lights the main flame in cases like those I have stated. In most cases it is never required, but it gives additional security to the constancy of the flame.

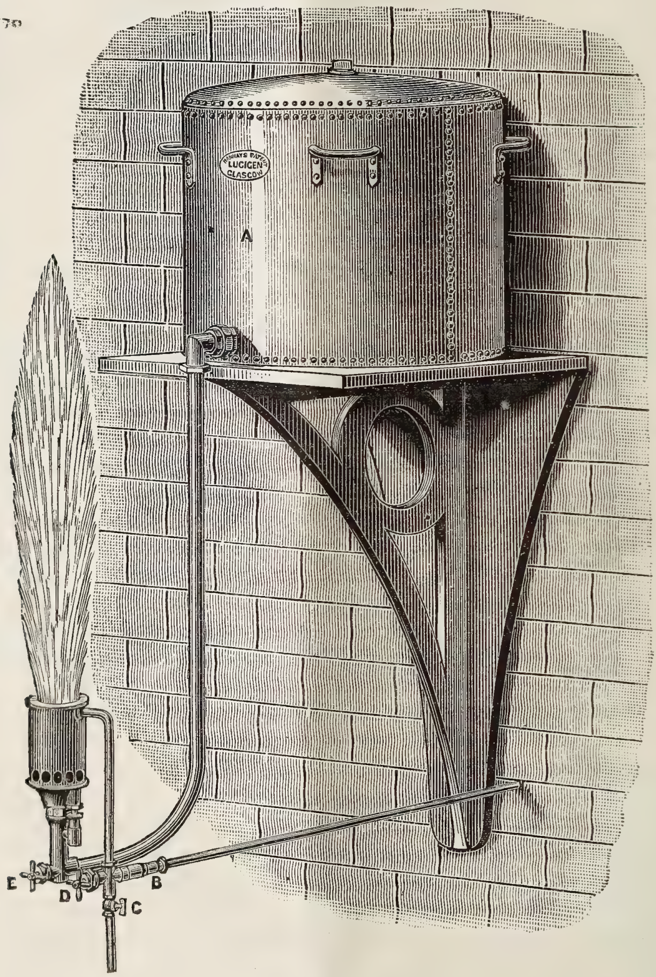
There is one use to which I hope to see the Lucigen applied, in which this re-lighting arrangement would be very useful. I hope, before many years elapse, every ship which crosses the great highway of the Atlantic, or makes for our ports through our crowded channels, will carry, instead of the red and green lights so often invisible or deceptive in a slight haze, one or two Lucigens, which will light up the ship and the surrounding sea so clearly that the masts, spars, and hull of the vessel will be visible for miles, for it must be remembered that the great flame renders clearly visible surrounding objects, and does not give the blinding glare of the electric light, which renders all but itself invisible, and thus the approach and course of that ship will be as apparent as in broad daylight. Were such an arrangement carried out, the mysterious disappearances of so many fine ships would, I believe, be greatly diminished in number. The re-lighting arrangement would admit of the use of a push-stop valve being applied to the main oil supply, and anyone acquainted with the Morse alphabet could telegraph to a passing ship by the dot and dash system, by means of this key-stop valve. When the main flame was extinguished for the period of darkness, it would re-light itself at the messenger, which is invisible.

From the description of the apparatus already given, it will be seen that a large proportion of the air required to support the combustion of the oil is drawn in by aspiration, so that when steam is used instead of air as the disintegrating medium to form the oil spray, its choking effect on the flame is very small, and the light appears to the eye to be almost as good as when the air is used. When

steam is used, however, the apparatus cannot be arranged for the pressure of the steam to drive up the oil, as is the case when air is used, because the steam must not be allowed to come into contact with the oil, as it would destroy it for burning. The steam-lamp must therefore be arranged either so that the oil will flow to the burner by gravitation, or that it is forced up to the burner by the pressure of the steam supplied to an extensible chamber contained inside the oil tank. In this case the condensed water formed in the tubes between the boiler and the lamp is led into this chamber, so that it is filled with water backed by steam-pressure.

In earlier patents the oil was raised to the burner in steam-lamps by suction, the burner being formed like an ejector, and the oil so

Fig. 5,

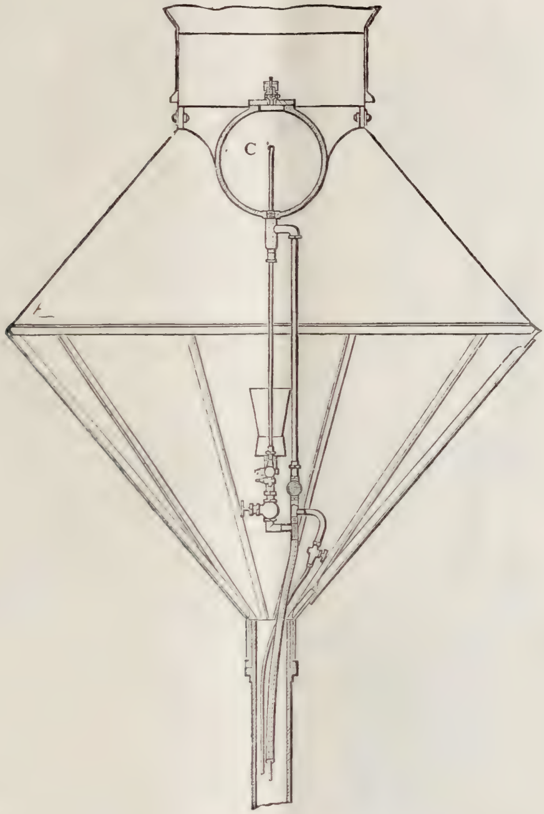


aspirated was burned with its mixture of steam. The great volume of the latter required to aspirate the oil choked the combustion so much that the flame became yellow, and much oil passed through the flame unconsumed. This is fatal to any light, because the finely divided creosote floats in the air and causes the eyes to smart, and objects all around get a shower of tarry oil. In the lamp under consideration these troubles are all carefully avoided.

In Fig. 5 is shown an arrangement for the supply of oil by gravitation, and as the fall of the oil is so very short, and the pressure hence so slight, the burner is arranged with the steam in the middle of the oil, and the opening for the latter rather large, so that the flow may be sufficient for a large flame.

The heat from the lamp may be further utilised to raise steam to disintegrate the oil, and in Fig. 6 is illustrated this form of apparatus. It will be apparent that it is impossible to start this lamp with steam, as until the flame is started there is no heat by which the steam can be raised. It can be started, therefore, either by a hand-pump or by the following simple contrivance. The water is allowed to run into a tank underneath the ground until it is half-full, when the imprisoned air will have acquired a pressure of 15 lbs. on the square inch. The water is now turned on to the extensible water chamber in the tank containing the oil, and the air and oil being now under the proper pressures, the valves are turned on and the lamp lit. In about 40 seconds the copper chamber, C, is hot enough to produce the steam, and the water is now turned gently on until steam issues freely from a small try-cock at the base of the burner.

Fig. 6.



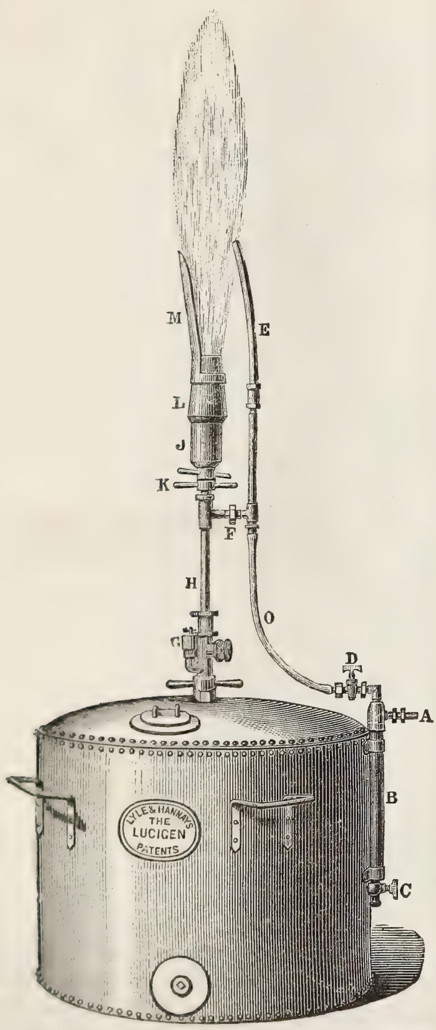
As soon as the steam issues dry the cock for the admission of the air is closed, and the lamp will now run perfectly steadily as long as the oil lasts. Of course, as the flame must impinge on the copper, C, this form of lamp must be inclosed in a lantern, to protect it from the wind.

Where a supply of water at a reasonable pressure can be had, the compressed air may be supplied from a pump driven by a small water motor. Apparatus of this kind has been used with great success.

Where for outside purposes, or for fixed workshop purposes, regulation of the size of the Lucigen flame is not required, the earlier forms of the apparatus may be used. In this form, (Fig. 7, p. 62) the air-supply with moisture-trap is arranged much the same as in Fig. 1, but the air passes by the india-rubber tube, O, to the vertical super-heater, E, which is a double tube. The air passes up the inner tube and returns down the outer tube, E, which is of copper, and through by the union, F, to the burner. The tube, H, which supports the burner, is also

double, the inner tube passing right to the bottom of the tank. and being thus immersed in the oil. The compressed air passes down the outer tube, and pressing on the surface of the oil in the tank, drives it up the inner tube to the burner. The regulation is performed by turning the burner, J, which has a cone ground accurately to fit the cone of the inner

FIG. 7.



oil tube. By this means the air and oil are regulated, because if the burner is screwed up the air gets freely to the outer cone and presses back the oil, while, if it is screwed down, the air is checked and the oil comes more freely. When the flame has been properly regulated, the jam nut, K, is screwed hard against the burner, which is thus held firmly at the required regulation. The burner in this case is not of the hot-air aspirating pattern, but simply a closed burner.

A form of Lucigen is also arranged for a break-down plant, with a portable compressor and receiver, which can be wrought by two men. This form of the apparatus was largely used in the recent mobilisation experiments by the French Government, as it was found to be much superior to electric lighting for training horses and drilling troops at night.

The characteristic of all these lamps is, that they yield an intense white flame of about 2,500 actual candle-power, with a consumption of two gallons of crude oil per hour. I say actual candle-power measured by an ordinary gas-tester's photometer, because we hear so much of so many candle-power "nominal" in the case of electric arc lights, that I think, once for all, illuminating power should be honestly stated by the best standard known. In trying the Lucigen flame near a group of four electric arc lamps of 2,000 candle-power "nominal" each, it was found, to my great astonishment, that the Lucigen was much brighter than the four arc lamps put together. As it was yielding about 2,500 actual candle-power, it follows that each 2,000 "nominal" electric arc was really under 600 candle-power. Such "nominalness" is rather striking. Besides its great diffusive power and broad glow of light, the Lucigen has many advantages, which have led to its adoption in all the important engineering and shipbuilding centres in Britain. The first is its low cost, being only, compared light for light, one-tenth that of gas, and hence one-twentieth of electric light, if the latter is applied so that work can be done, because the electric arc is useless as an artisan's light. Electricity, to be of use for detail work, must be applied in the incandescent lamp form.

The second advantage is its extreme simplicity. Anyone can manage and regulate the light, and any failure must arise from some easily discoverable cause. Such has been its success in a short time, that already the most extensive engineering works in the world are laying down tubing for the compressed air to light their entire works, while their expensive electric lighting plant will be disposed of in the way which will entail the least loss. Railway companies have laid down this plant for lighting their shunting operations at night, and by leading both oil and air, under pressure, in tubes to the burner fixed to a post, the

light may be produced at long distances from the sources of oil and air. Already the system has been extended half a mile from the compression pumps, and it will soon be extended to over a mile. This system is thoroughly suitable for lighting cities, the motive-power being small steam or gas-engines at suitable intervals. The apparatus as at present used by some of the leading railway companies in this country is illustrated in Fig. 8.

This brings me to the second part of my subject—the production of heat from oil.

In the first place, I may remark that we have been so long accustomed to use coal for producing heat, that the methods hitherto followed in regard to oil have been simply slight alterations in the forms of furnace already in use for coal. It will be plain, however, to anyone that the two cases are entirely different, and inasmuch as the oil leaves no ash, requires no supporting bars, and can be introduced anywhere in the furnace, I think that the old forms of furnaces are bound to be entirely abandoned before really good results can be obtained from oil. Therefore, the apparatus I am about to describe to you is, I may say, merely the results of the first crude trials in the direction of the proper utilisation of oil for producing heat, and although highly successful as far as yet applied, I feel that for larger operations much better and more economical furnaces will yet be invented.

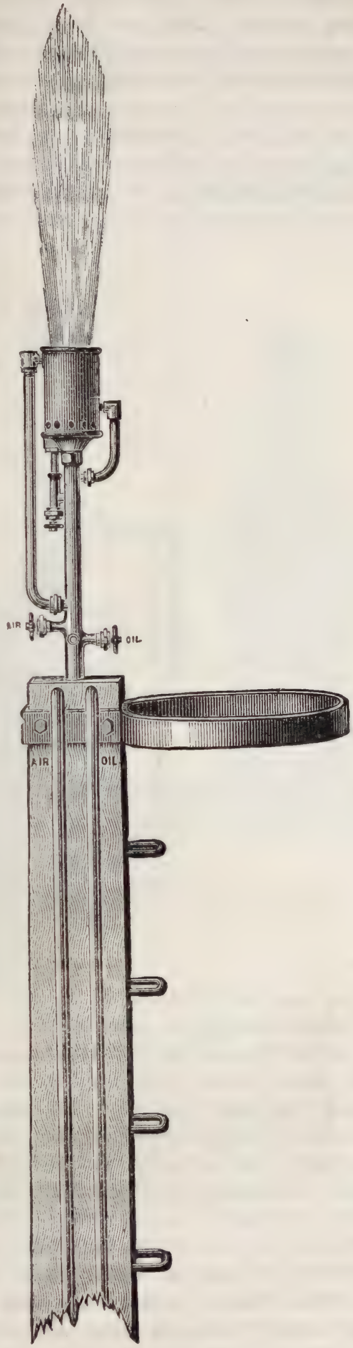
The first point which strikes one about the use of oil for heating is, that there are many operations for which small isolated sources of heat are required, such as the multitudinous articles manufactured out of bar and sheet iron and steel, which require to be stamped, punched, or shaped, while still hot. For all these purposes the oil furnace is especially suitable, and as each furnace must be constructed for the special purpose to which it is to be applied, I shall describe one form as typical of the method, the other forms being merely varieties.

The form I shall describe is that used for heating rivets for modern rivetting machines, shown in Fig. 9. (p. 64.)

This furnace being specially designed for the economical and quick application of heat, has been called the Pyrigen, or fire producer.

In my earlier experiments, it was attempted to apply the principles which Siemens laid down for coal furnaces, *i.e.*, regenerative action in the furnace, and allowing the flame to do all its work by radiation, touching the brick as little as possible. A furnace constructed on these principles acted very fairly, but on comparing the heat obtained with

FIG. 8.

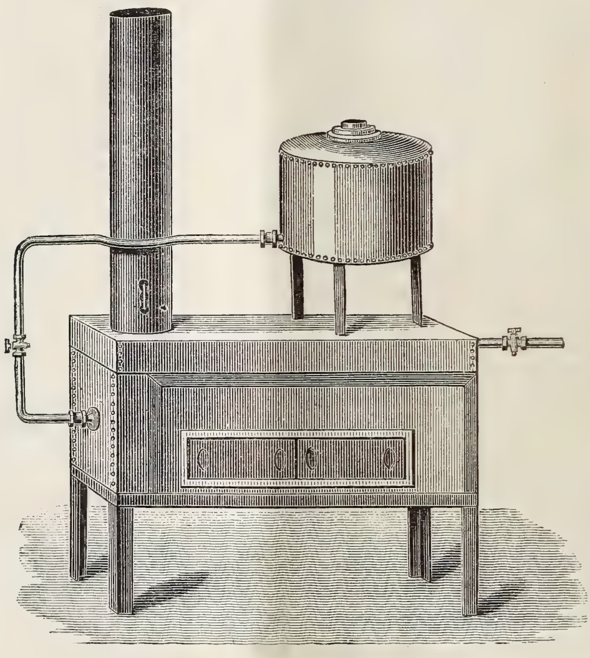


that produced by merely playing the flame into a confined brick space, where it got churned about, it was seen that to this sort

of fuel Siemens's rules for the economical production of heat from coal did not apply. He taught that whenever the flame touched brick, it underwent dissociation, and the temperature attainable was very much lowered. Now, after a long series of of experiments, during which many different forms of furnaces have been constructed, the conclusion has been irresistibly forced upon me that in the kind of flame with which we are dealing, the more the flame touches the brick, the higher a temperature we get, and my whole ingenuity is spent in doing absolutely the reverse of what Siemens advised, namely, in devising furnaces in which the flame is baffled by the form of the brickwork, and churned about, and, as it were, rubbed against the brick as much as possible. It is found that a furnace constructed after this plan may be maintained at the same temperature as a Siemens's furnace of the same size, with a combustion of only one-fourth of the amount of oil.

The results obtained by this furnace are somewhat remarkable. On first turning on the oil, the flame is simply like the Lucigen, and the rivets may at once be heated by

FIG. 9.



heaping them up in front of the flame. But as the furnace heats up the flame becomes larger, and, if the flow of oil be not decreased, it would pass round into the chimney and produce smoke. As the oil supply is diminished, the flame becomes more and more transparent, till a point is reached when "flameless combustion," so well described by Mr. Fletcher, of Warrington, is obtained and the inside walls of the furnace simply glow with a white heat without any visible flame. This is the most economical form of furnace heat, as the gases only combine when touching the solid surface (and yet do not wear that surface like an impinging flame), and hence the furnace glows with an intense quiet heat, which quickly raises to a high temperature any articles exposed on its floor.

The atmosphere to which the articles are exposed in this furnace is one which, from its peculiar character, is well calculated to preserve the articles from oxidation or other deterioration. It contains no sulphur, no dust, and no free oxygen, as the oxygen is all required to combine with the hydrocarbon of the oil, and hence iron or steel may lie there for hours without being in any way destroyed.

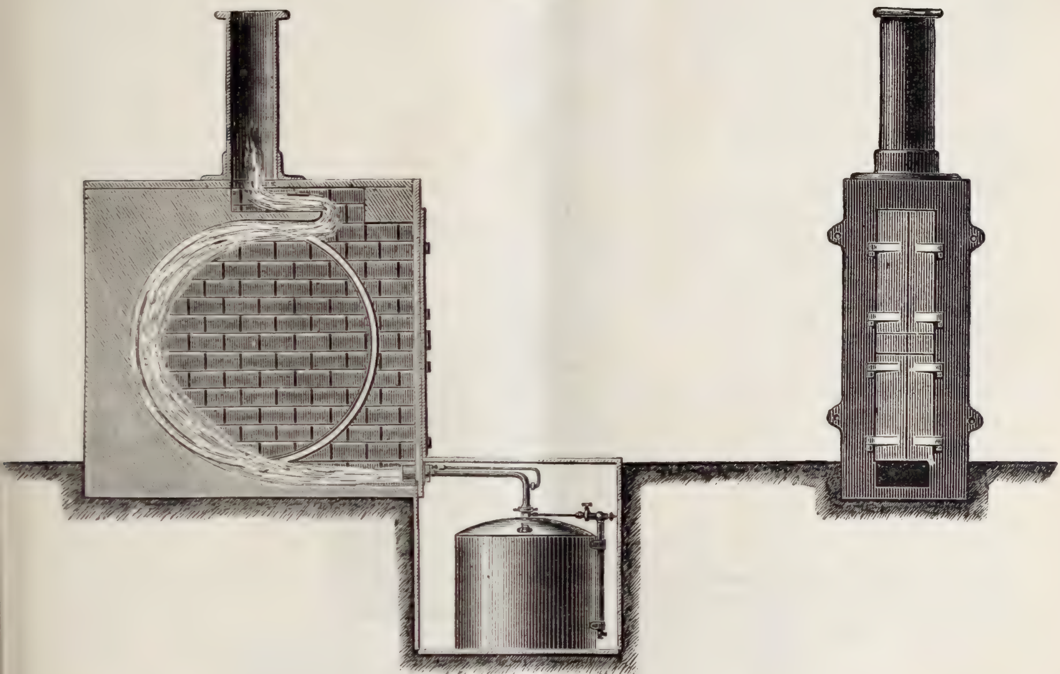
In all other operations requiring quick heating with purity of atmosphere the Pyrigen flame is peculiarly well adapted, and the following may be mentioned as some of its various uses:—

It is specially well adapted for heating iron,

for making bolts, rivets, and nuts, and has many advantages over the ordinary rivet iron furnace. There is no loss from destruction of firebars or bricks, and no dust or ashes, while the cost of oil required for combustion is not one-third that of coal, the iron at the same time being maintained in its pure condition, and not burned nor sulphurised as when coal is used.

The increasing use of fixed and portable rivetting machines in ship-building, bridge-building, and other engineering operations, calls for an economical and systematic method of heating rivets as a matter of the highest importance. The Pyrigen is admirably adapted for this purpose, as by its use the rivets can be regularly supplied in any quantity to the machines at the required temperature. The furnace can be made ready for use in ten minutes, and the temperature kept steady, and under perfect control, while the iron is in no way injured, and the rivets are not subject to the usual per-centage of loss which takes place when coal is used for heating. Further, the Pyrigen, being portable, can be readily shifted according to the requirements of the work—all that is required being a connection to a supply of compressed air.

FIG. 10.



Another useful application is for heating the steel or iron tires for shrinking on to the wheels of railway carriages or wagons and ordinary coaches, the labour and expense of the usual methods of heating being superseded at a much less cost, as the Pyrigen can be got ready for heating in a few minutes, and the flame turned off when not wanted. Fig. 10 shows the Pyrigen arranged for heating coach tires.

It can also be effectively and economically adapted for angle iron and plate re-heating, as employed by boiler and bridge makers, and is greatly superior to the ordinary furnaces, as by its use the heat can be regulated at pleasure, and the iron kept clean and free from scales.

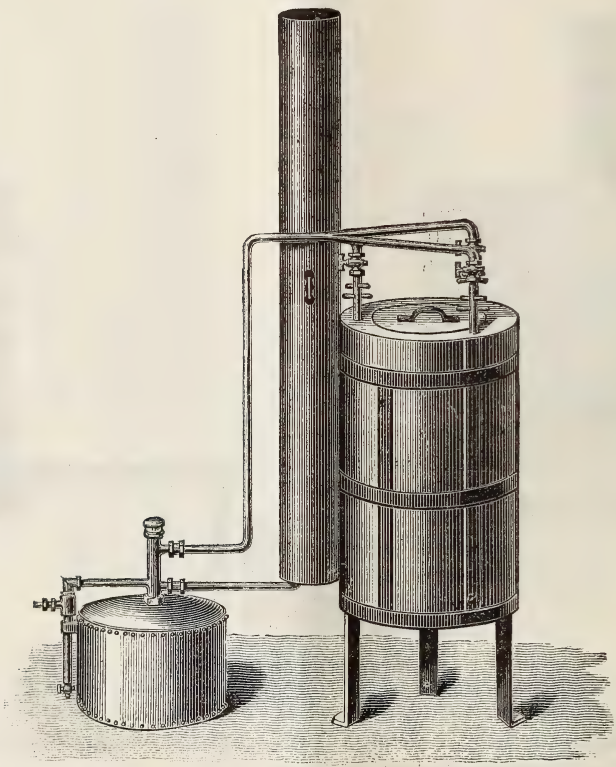
The horizontal form of Pyrigen is also suitable for a great variety of other heating purposes, as metals treated in this furnace can be raised in a very short time to a welding heat; while their purity and tensile strength are not in the least degree injured, as the atmosphere is entirely free from either sulphur or phosphorus, and no carbon is present in any form which would enable it to combine with or deteriorate the iron.

This form of furnace is also well adapted for cupelling and other special metallurgical operations where a high temperature and

purity of atmosphere are required. The sharpness of the heat of this little furnace may be judged from the fact that a cold brass casting of several pounds weight thrown on the hearth began to melt in 45 seconds, and was completely liquefied in 55 seconds.

Fig. 11 illustrates the vertical form of furnace for heating crucibles, as in brassfounding, fluxing, bullion smelting, &c., and conducting other operations where it is desirable to surround the object with flame either of an oxidising or a reducing character. The capabilities of such a furnace may be learned from a trial of brass melting in a crucible. The crucible, 8 in. by 12 in., was put in cold, filled with broken brass castings, and the whole brass was liquid, and, in fact, much too hot, in twenty minutes. Of course such rapid heating cracked the crucible. Starting with the crucible of the same size hot, the brass was liquid and ready for pouring in four minutes and a half. This constitutes a most important advantage of the Pyrigen over heating by coal or coke, as by merely turning a tap the flame may be changed in an instant from oxidising to reducing, or *vice versa*, while

FIG. 11.



the temperature can be raised to any given point, and be maintained there perfectly steady for any length of time.

This absolute steadiness with which any given temperature may be maintained, renders the Pyrigen very valuable in such operations as japanning, vulcanising, annealing, &c., all the arrangements being of the simplest nature.

As in the case of the Lucigen, it can be wrought by compressed air or steam, the best and most economical results being obtained by the use of the former, but where compressed air cannot be conveniently had, steam may be used, it being superheated by passing through the flue before reaching the burner.

Any kind of crude oil, creosote oil, tar oil, or gas tar, may be used in the Pyrigen, the oil tank and service pipe being so arranged that the oil or tar is gently heated before combustion.

In Fig. 9 the oil tank is shown so arranged that the oil flows by gravitation to the burner; in Fig. 10 the tank is shown having a jet of compressed air applied to it to force the oil

to the burners. Either method can be used, but the former is necessary when steam is used for disintegrating the oil.

The Pyrigen burns without smoke or smell, and as it gives off no irritant gases, it can be used inside an ordinary engineering shop without the slightest inconvenience, while the burner and tank are constructed similarly to the Lucigen, and may be used for lighting the workshop when not in use for the furnace.

Before closing, I may briefly refer to the use to which oil may be put when the vast stores have been opened up, and the distribution effected in an economical way. At present the limited quantity at our disposal renders the use of oil for steam-raising for ordinary commercial purposes quite out of the question, because the amount required for even a few Atlantic liners would exhaust the supply, and raise the price beyond the economical limit. But there are special circumstances in which it is desirable to raise steam with as small a weight of fuel as possible. The modern torpedo boat or fast cruisers are vessels in which the saving of weight in the fuel used is of far more importance than the price of the fuel. This consideration caused me to conduct a series of experiments on a land boiler of locomotive type, with the unexpected result that 6 cwts. of oil-fuel raised as much steam as had been raised by one ton of small coal. This unexpected result, showing an efficiency of three times that of coal, caused me to look into the conditions under which heat is obtained from the two kinds of fuel. In the case of coal the combustion is irregular, and the average temperature of the gases passing up from the fire may not be over 1000° C., while, owing to the constitution of a coal fire, and the easy formation of smoke, large quantities of air require to be heated which take no part in the combustion of the fuel, in order to provide an excess of oxygen to consume the smoke. In the case of oil as consumed with my new burner, the combustion is quick and perfectly regular, and the exact amount of air required for combustion is heated, so that there is no waste, while the average temperature may be 1000° C. higher than in the case of coal, and hence the available heat immensely greater. Hence, it is not a question of the amount of energy in oil as compared chemically with coal, as they are nearly equal, but it is a question of the amount of available energy to be had from the fuel, an amount which depends entirely on the conditions of combustion of the fuel, and, in this respect, oil is greatly superior to coal.

The "available heat" is the amount of heat absorbed by the boiler, and communicated to the water, and is represented by the difference of temperature between the gases immediately over the burning fuel and that at which they pass away to the chimney. As the latter temperature is practically the same with equal volume passing away, but is lower with a smaller volume, it is plain that the higher the initial temperature of the gases, and the smaller their volume, the greater is the duty of the fuel.

In oil fuel, as dealt with by my new burner, there is a very high initial temperature, and the gases are reduced to the minimum, which will carry on complete combustion, so that the conditions are secured for a very high state of efficiency.

I have here roughly sketched types of the two important uses to which the immense reservoirs of oil in the earth's crust may be applied, and, no doubt, when these stores are properly worked, and the contents distributed over the globe as efficiently as wheat is at present distributed to hungry nations, the light and heat of the future will mainly be obtained from oil.

[At the conclusion of the reading of the paper a lamp of the smallest size was shown in operation.]

DISCUSSION.

Mr. H. H. Doty asked whether the oil used in the experiment was light oil or the heavy residuum of gas works, or what was known in the trade as "dead oil."

Mr. Whittle said that on this occasion paraffin oil was used, but they generally used creosote.

Mr. Doty said he understood it to be stated that superheated steam was best adapted for the generation of this light, but he had witnessed some experiments in that direction, the effect of which, he believed, was to show that low pressure moist steam was better for creating an oxy-hydrogen flame than highly heated steam. Admiral Selwyn had conducted a good many experiments in that direction.

Mr. Edmund Kimber said this was one of the most important subjects of the day, and the paper they had heard had in fact only just touched the fringe of it. There had been discoveries of oil recently in Beloochistan which would prove very im-

portant, and there were four or five different processes for utilising oil, each inventor claiming that his was the best. They were told the cost was one-tenth that of gas, and one-twentieth that of electricity, but he should like to know how that statement was arrived at. It was said that a light of 2,000 candle-power could be obtained for two hours from two gallons of oil, but they wanted further particulars. He had seen the large demonstration of this light at the outfall works at Barking, where there were nine or ten of these lights in operation. The first objection to this light was its noise, and another was the shower of oil liable to be produced. It was a grand thing to have it for large works, and the Metropolitan Board by its means were able to employ upwards of 1,000 men at night over 50 acres of ground, which in these days was an immense boon. It was also said that it might be used on board ship, but he feared the machinery was too complicated for such a purpose. He admitted that it was superior to electricity, and would show everything plainly around it; but how could the apparatus be secured in a storm, and what would be the result if a huge wave swept right over it? It was said that 6 cwt. of oil raised as much steam as a ton of coal, but the question was what was the comparative price of the two fuels. At the present price of oil it could not beat coal, because the lowest price of crude oil was 2d. per gallon on the Thames. No doubt it would go down when it was brought from Beloochistan. The oil would be supplied at 1d. per gallon, or £1 per ton. There were other vast fields of oil in North Venezuela, and another region had been opened in Vera Cruz, where there were 150 miles of petroleum, which could be brought to the coast for ½d. per gallon, and probably could be landed in England at ¾d. per gallon, or 15s. per ton. He did not think Scotch oil could be got into London for less than 4d. per gallon, and the crudest oil could not be got in the Clyde for less than 2d. per gallon, or £2 per ton, whilst coal could be obtained at 6s. or 7s. How, then, was 6 cwt. of oil going to beat the coal? It was an error to suppose that the use of oil in large quantities would send up the price; on the other hand, the increased consumption would send it down, because it would increase the demand, and immense quantities would be brought to England from all parts. A machine for extracting oil from the kimmeridge shale in Dorsetshire, Norfolk, Devonshire, and Somersetshire, for 10s. a ton, had just been patented, but it was not yet accomplished, and he feared that until these things came to pass, the Pyrigen and other modes of using oil for fuel would not come into general use. He was quite satisfied that oil was the fuel and light of the future, and would supersede gas, unless gas-makers produced their gas from oil. It would also supersede the electric light for household purposes, and immediately it was used in anything like quantity, the large capitalists of the world would be putting capital into these great ventures for the purpose of supplying England with oil at one half-penny per gallon.

Mr. Thomas Hilton said that Mr. Kimber had given a glowing account of petroleum, not at all too highly coloured, but he should like to know if crude petroleum had ever been used in the apparatus. It was necessary to settle this point, in order to be able to apply the observations of Mr. Kimber, because all the crude petroleum, as it arrived in this country, contained the volatile substance known as benzoline, or petroleum spirit, which, under ordinary circumstances, could not be burnt in a lamp constructed for burning oil, whilst the substances referred to in the paper did not contain that. What he wished to know, therefore, was, had the inventor used crude petroleum, because unless the lamp was so constructed as to avoid an explosion in the use of crude oil, the statement which had just been made as to the oil would scarcely apply. If that crude oil could be used, the inventor might go on with his invention, and produce his machinery with the assurance that he would never want for raw material. If the oil could be used in the crude form, it could be brought over in tank-ships much cheaper than any of the products referred to as a source of light; but if it had to be purified before it could be used, another element of cost was at once introduced.

Mr. Bromhead, having witnessed the exhibition of this light at the Crystal Palace, could bear testimony to the fact that it appeared remarkably well adapted for illuminating large open spaces; at the same time the roaring noise which seemed to be unavoidable, would in many cases be a great objection, and he should like to know if there were any chance of reducing that. Although a newspaper could be read very well at a distance of 500 yards from the light, the noise, which was like that of a great storm, would prevent the Lucigen from being used for the purpose of outdoor assemblies. He was told that the estimate of the cost of the light was based on the price of tar, which the last speaker had not mentioned.

Mr. Kimber said the price of tar at the gas works, in large quantities, was one half-penny a gallon.

Mr. Bromhead said he understood that two gallons were capable of supplying the light for two hours, but in addition to the cost of the tar, there was the machinery and labour for supplying the compressed air.

Mr. E. Mansfield said the only fault he had to find with the paper was that it claimed a little too much, and that it only dealt with one branch of the subject; he thought from the title that it would have been on the uses of waste oils generally. The Manchester Exhibition, which had proved so great a success, was not begun very early, and had it not been for the extensive use of the Lucigen light, it was doubtful whether

the contractors would have got the building ready in time. The light was also being used in connection with the works of the Manchester ship canal, and for such purposes it was excellent, but he doubted if it could be extensively used for other purposes. The noise was very objectionable, and so was the oily spray which had also been alluded to. There were, however, other uses to which these cheap oils could be put. He was delighted at the opinion of Mr. Kimber that the more these oils were used the cheaper they would become. This had not occurred to him before, but he had no doubt it was correct. Ordinary gas for domestic use had been made from these oils, and he had brought a sample with him. Many people had the idea that oil-gas was offensive, and that it condensed readily in cold weather, and was dangerous, but this was a mistake. It had this advantage, that it only contained the ingredients which were wanted, carbon and hydrogen, whilst in the coal from which gas was usually made there were also sulphur and nitrogen, which were objectionable. A very interesting experiment with regard to waste oils had been carried out in Manchester. A large business was carried on there with the destructor, in which the refuse from ashpits, and also animal refuse from slaughter-houses, and other effete matters were consumed, and they had accumulated a great quantity of oil from the stale fish, dead cats and dogs, and other animal matters, which they did not know what to do with. Then it occurred to the Superintendent of the Health Department that he might make gas from the refuse, and this was done at the Exhibition. The chemist from the Health Department watched it closely, and was delighted to find that 94 cubic feet of gas could be made from a gallon of this oil, for which no market could be found. Four or five stands at the Exhibition were beautifully lighted up by it, and one of Crossley's engines was run a whole day with it. Mr. Fletcher, of Warrington, had tested oil-gas with him in his laboratory, and they found, to their surprise, that it had three times the heating power of coal-gas. Its application was exceedingly simple, all the alteration required in the usual apparatus being to reduce the inlet for the gas to one-third, leaving the air inlet as before. Messrs. Crossley Brothers had also experimented with it to a certain extent, but while they found that, theoretically, it had three times the driving-power of coal-gas, they had as yet only succeeded practically in getting double the power from it. The sample he had brought was made from ordinary mineral oil, after the richer portions had been taken out, that which was commonly called intermediate shale oil, because the labour bestowed upon it was repaid by the richer constituents which were removed. He found that in bringing it in an indiarubber bag, some of the gas had escaped, and been replaced by air, so that it was not a fair sample. Ordinarily speaking, the flame from a No. 2 burner, with this gas, was as large as that from a No. 4 with ordinary coal-gas. One gallon of oil produced 100 cubic feet; and the candle-power, as tested by Mr. Thomas Newbigging, was four times that of ordinary coal-gas.

Mr. KIMBER remarked that Mr. Avery in the United States, claimed to make 300 feet per gallon, but not of such high candle-power.

Mr. MANSFIELD said Mr. Avery's gas was mixed with hydrogen.

Mr. EDWIN LUCAS said he could bear testimony to the efficacy of the light, having used it for some time when engaged in erecting Olympia at Kensington. His firm had a large number of workmen employed there, and the light was very satisfactory, as it cast no shadow, and the work could be proceeded with in every part of the building. It might be very usefully employed in ironwork construction in an elevated position, for in this very building several accidents nearly occurred through the falling of red-hot rivets. These rivets were heated at some distance below the staging, and thrown up by hand, and if the boy in attendance failed to catch them, they fell, and on one occasion he himself had a narrow escape from one of these falling rivets. It occurred to him that by the use of this apparatus the rivets might be heated close to where they were wanted. There might be a further use for this oil in combination with the waste products of large cities. In London, he had ascertained there were about 700,000 tons of cinders made annually, which were to a large extent wasted, but if they were washed and charged with this oil, they would supply a large amount of heating and illuminating power at a small cost.

Mr. WHITTLE (who represented Mr. Hannay), in reply to the questions which had been put, said that in using steam they were accustomed to wire-draw it, so as to reduce the pressure. The price of the creosote they ordinarily used was 1½d. per gallon in Manchester, and it was much cheaper in Glasgow. He had never used crude petroleum, and was not aware that it had been used, unless it was in New York; but he did not think there would be any danger of explosion. Of course, if a large wave went over the flame it would put it out. It was a very powerful light in a fog. The reason they had not used crude petroleum was not because they were afraid of a deposit of carbon or clogging, but simply that they had not got it, and they had plenty of creosote. The light could be supplied at threepence an hour for a 2,000 candle-power light. He did not think it would be possible to get rid of the noise.

The CHAIRMAN then proposed a vote of thanks to Mr. Hannay and to Mr. Whittle, which was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

DECEMBER 7.—"The Chemistry, Commerce, and Uses of Eggs of various kinds." By P. L. SIMMONDS. J. A. YOUL, C.M.G., will preside.

DECEMBER 14.—"Commercial Education." By SIR PHILIP MAGNUS. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

CANTOR LECTURES.

The First Course will be on "The Elements of Architectural Design." By H. H. STATHAM. Four Lectures.

LECTURE II.—DECEMBER 5.—Influence of the mode of covering in on the general design.—The two systems of covering spaces, the beam and the arch.—Definition of "style."—Statical conditions of the beam system.—Its architectural expression as worked out by the Greeks.—The column.—The entablature.—The three styles employed by the Greeks.—The superstition of the "Five Orders."—Roman and Renaissance application of Greek forms.—Value of ancient classical forms to modern architecture.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. H. H. Statham, "The Elements of Architectural Design." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Prof. Wallace, "The Agriculture of India."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Edgar C. Thrupp, "A New Formula for the Flow of Water in Pipes and Open Channels."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Prof. Dewar, "The New Weldon-Pechiney Process, for the Manufacture of Chlorine from Magnesium Chloride."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. R. Rich, "Allotment Legislation." 2 Mr. M. Jeans, "Allotments and Small Holdings."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Nevill, "The Auditorium of a Theatre."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Prof. G. E. Post, "The Botany of Syria."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Andrew Laing, "The Wanderings of Puss-in-Boots."

TUESDAY, DEC. 6...Metropolitan Medical Provident Association (at the HOUSE OF THE SOCIETY OF ARTS).

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Edw. Hopkinson, "Electrical Tramways: the Bessbrook and Newry Tramway."

Statistical, Willis's-rooms, King-street, St. James's, S.W., 7¾ p.m. Opening Address by the President, the Right Hon. G. J. Goschen.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Farmer's Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Annual General Meeting.

Zoological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, DEC. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. P. L. Simmonds, "The Chemistry, Commerce, and Uses of Eggs of Various Kinds."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Annual Meeting.

Geological, Burlington-house, W., 8 p.m. 1. Dr. Archibald Geikie, "The Age of the Altered Limestone of Strath, Skye." 2. Prof. H. G. Seeley, "*Thecospondylus Daviesi*, Seeley, with some Remarks on the Classification of the Dinosauria." 3. Dr. Henry Woodward, "The Discovery of Trilobites in the Upper Green (Cambrian) Slates of the Penrhyn Quarry, Bethesda, near Bangor, North Wales."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. F. Merrifield, "Report of Progress in Pedigree Moth-breeding, and Observations on Incidental Points." 2. Mr. G. F. Mathew, "Life Histories of Rhopalocera from the Australian Region." 3. Mr. G. T. Baker, "Descriptions of New Species of Lepidoptera from Algiers." 4. Mr. C. O. Waterhouse, "Exhibition of Diagrams of the Wings of Insects, with Observations on the Homologies of the Veins."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Opening Address by the President.

THURSDAY, DEC. 8...Hospitals Association (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m..

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture I.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Annual General Meeting. Mr. Arthur C. Cockburn, "Safety Fuses for Electric Light Circuits, and the fusing points of various metals usually applied in their construction."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, DEC. 9...Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Paper by Miss Grace Latham.

SATURDAY, DEC. 10...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. H. G. Madan, "Optical Properties of Phenyl-thiocarbimide." 2. Mr. H. Tomlinson, "Recalescence of Iron." 3. Dr. H. C. Shettle, "Rotation of a Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,829. Vol. XXXVI.

FRIDAY, DECEMBER 9, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ART-WORKMANSHIP EXHIBITION.

The Exhibition of specimens of painted glass, blown glass, inlaid wood, decorative painting on wood and other materials, hand-tooled bookbinding, and repoussé and chased work in metal, sent in competition for the prizes offered by the Society of Arts, is open to-day, Friday, 9th inst., and will remain open until Friday, 23rd inst.

The Exhibition will be open daily from 11 till 6, and from 11 till 9 on Mondays, Wednesdays, and Saturdays.

Members can admit their friends by the use of the usual meeting tickets supplied at the commencement of the Session. There will be no restriction on the number of tickets which can be issued by each member.

Non-members can obtain tickets on application to the Secretary.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 5th and 11th, 1888, by Mr. WILLIAM HENRY PREECE, F.R.S., on "The Application of Electricity to Lighting and Working." The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

Mr. H. H. STATHAM delivered the first lecture of his course on "The Elements of Architectural Design," on Monday evening, 28th November, and the second lecture on the 5th inst. In the first lecture he enlarged upon the range and capability of architecture as an art, and dealt more particularly with the plan, both in its relation to exterior design, and when considered as itself a form of artistic expression.

In the second lecture Mr. Statham showed the influence of the mode of covering-in on the general design, and dealt with the two systems of covering spaces, viz., the beam and the arch. He then defined style, and explained the Greek mode of working out architectural expression, and concluded with remarks on the application of Greek forms by the Romans, and at the Renascence, and in modern architecture.

The lectures will be printed in the *Journal* during the Christmas recess.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 7th, 1887; J. A. YOUL, C.M.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Bell, Frederick Augustus, 14, Anerley-park, Anerley, S.E.

Fegen, Charles Milton, M.R.C.S., L.R.C.P., Cairo.

Harrison, Thomas Henry, 22, Granville-villas, Earlsfield-road, Wandsworth, S.W.

Levy, B. W., 25, Pembridge-gardens, Notting-hill, W.

Martin, John Biddulph, 17, Hyde-park-gate, S.W.

Nichols, Daniel Cubitt, 3, Howard-street, Strand, W.C.

Savidge, Frederic William, Stretham, near Ely.

Stretton, Clement Edwin, Saxe-Coburg-street, Leicester.

The following candidates were balloted for and duly elected members of the Society:—

Bridger, Lowther, General Post-office, E.C.

Child, Robert, 62, Hampstead-road, N.W.

Emden, Walter, 36, Southampton-street, Strand, W.C.

Gotz, John R., 19, Buckingham-street, Strand, W.C.

Greenaway, Lieut.-General Thomas, Staffa-lodge, Guildford.

Logan, William George, 11, John-street, Adelphi, W.C.

Scriven, Richard, Castle Ashby, Northampton.

Skilton, Charles Henry, St. Leonard's, Barry-road, East Dulwich, S.E.

Walker, William H., 7, Romola-road, Herne-hill, S.E.

The paper read was —

THE CHEMISTRY, COMMERCE, AND USES OF EGGS OF VARIOUS KINDS.

By P. L Simmonds, F.L.S.

Some excuse is perhaps necessary for bringing a subject so apparently insignificant as Eggs before the Society, but when we consider that our deliberations are concerned with Agriculture and Commerce, as well as with other topics, the details I have to offer will, I think, prove that the trade in this food article, and the considerations connected with it, are more important than is generally supposed, especially as we pay nearly £3,000,000 yearly for our foreign supply of eggs. We import from the Continent more than 3,250,000 eggs every working day of the year, and if our home supply is added, the importance of this product must be manifest, and the use and importation of eggs increases vastly from year to year with the increase of population.

Thirty-one years ago I published a long descriptive article on the "Trade and Commerce in Eggs and Poultry" in the Edinburgh *Journal of Agriculture*, but the subject has attained vast proportions since then, for at that time we only paid £278,000 for foreign eggs.

Without confining myself entirely to the mere utilitarian and commercial aspect of my subject, I propose to diverge a little into the scientific and general consideration of eggs of all kinds, although, in the limited time at my disposal, I can only skim over the surface and give a few brief details.

The eggs of birds have always been the object of observations more or less scientific, and have never ceased to be a subject of curiosity. From the curiosity of science there is but one step; it is the history of Pandora's box.

Eggs can be considered under many points of view. Their general study is named Oology, and includes the investigation of the shell and contents of the egg. Oology is therefore, the study of the configuration of the egg as a physical body, containing various liquids and membranes, of which the calcareous shell is the envelope. Hence it is the most circumscribed and modest of the investigations of which the egg is the object. But even in this respect there are many things to be considered. There is the number of eggs produced, which is very variable in different species of birds, the size and weight of the eggs, the nature and composition of the shell, and its colour. We find great variation in the number laid by each kind of bird, as well as in the weight, form, and markings, and eggs are among the most attractive and ornamental objects collected.

What a subject has scientific research found in eggs as a study; witness the works of Moquin-Tandon and O. des Murs*. These publications serve to show how the oologic characteristics may assist in the methodical classification of birds, what relation there is between the egg and the organic conformation of the bird, and what particular habits of birds may be gathered from a study of their eggs and nests.

Number of Eggs.—Some birds only lay a single egg, others many. The largest ordinary number, on the average, is five or seven. The species laying less are more rare than the species laying a larger number. Those in a state of liberty produce, on the average, 12 to 15. But in domestic poultry the number is larger. Farmyard hens average 60 or 70 eggs in the year. And certain Cochin China fowls are said to lay from 200 to 300 eggs.

In the second part of his work, which treats of oologic characteristics, M. des Murs deduces, by evidence and study of the special characters of the egg in its calcareous integument, certain rules, sufficiently fixed for serving as the base of a series of scientific propositions, of which the following are the principal :—

I. If the form of the egg is most generally oval, it submits to the following modifications, which are found constant in certain groups, for example :—

1. Oviform in the Tinamidæ.
2. Elliptical in the grebes, the cormorants, and the pelicans.
3. Oviconic in the penguins, the guillemots, and most of the Grallipedes, or waders.
4. Cylindrical in the Megapodes, and the Gangas.

* "Traite General d'Oologie Ornithologique," par P.O. des Murs.

II. The aquatic birds, or swimmers, have generally the surface of their eggs less polished and lustrous.

III. The colour of eggs does not vary in any manner in the same species, in one climate or another, notwithstanding the assertion of a recent author to the contrary.

IV. The markings, although they vary greatly from one species to another, are nevertheless constant in many groups of the species which compose them; for instance, white among the pigeons, uniform and without spots among the pheasants and Tinamidæ (*Rhychotes*), whatever may be the colour of the eggs.

V. Finally, the general form of the spots, apart from their colour, is equally constant in many groups, as, for example, among the yellowhammers, the Quiscalinae, and the greater part of the Icteridæ.

The number of eggs laid is less at the commencement and end of life. With hens, for instance, the number laid is less in the first and fourth year than in the second and third, and after the fifth year, generally, they cease laying. Chickens and ducklings, which can generally shift for themselves soon after emerging from the egg, are more numerous in a brood than young pigeons, which have to be fed by the parent. But if pigeons only lay two eggs at a time, they lay more frequently—once or twice a month, and hence rear a large number of young.

The author of "British Oology" observes:—

> The number of eggs laid by various tribes of birds, as well as the different genera of the same family, vary much. The more typical species of these, however, are for the most part nearly alike in this respect. In every instance we shall find the same beneficent influence acting for our welfare; increasing rapidly, by the number of their eggs, those species which are of the greatest use to us, and bestowing upon those intended for our more immediate benefit a most wonderful power of ova-production; and at the same time curtailing in their numbers those species which, in their greater increase, would soon become injurious to us. Most of the Rasores, which as game form so agreeable an addition to our table, as well as the Duck tribe, lay numerous eggs.

Shape of Eggs.—In form and general aspect the difference among birds' eggs is endless. Some are elongated, some are spherical, some are dull on the surface, some are polished, some are dark, others grey or white, others very bright. The shape of eggs offers as much diversity as their size and weight. They may be thrown, however, into six principal or typical forms—the cylindrical, the oval, the spherical, the ovicular, oviconical, and the elliptic. The ovicular form of egg belongs to the Passeræ and Gallinaceæ, the ovoid to the rapacious birds and the Palmipedes, the conical to the wading birds and some Palmipedes, the short to some game and many stilted birds, and the spherical to nocturnal birds of prey and the kingfishers.

Size of Eggs.—Mr. W. C. Hewitson observes that in their relative sizes the eggs of different birds vary in a remarkable degree from each other. The guillemot and the raven are themselves about equal in size, but their eggs differ as ten to one. The snipe and the blackbird differ but slightly in weight, their eggs remarkably. The egg of the curlew is six or eight times as large as that of the rook; the birds are about the same size. The eggs of the guillemot are as big as those of an eagle, while those of the snipe equal the eggs of the partridge and the pigeon. The reason of this great disparity in size is, however, obvious. The eggs of all those birds which quit the nest soon after they are hatched, and are consequently more fully developed at their birth, are very large, and yet so admirably formed to occupy the least possible space, that the snipe has no more difficulty in covering its eggs, though apparently so disproportionate, than the thrush or the blackbird. Hence we see that eggs are not always proportioned to the size of the birds which lay them. Many of the aquatic birds, and some of the Gallinaceæ, lay eggs out of all proportion to the size of the birds.

Domestic fowls have larger eggs than those in a wild state. The eggs of the wild duck, for instance, are only 50 to 55 millimetres in diameter, while those of the tame ducks are 60 to 65 millimetres. In general, the eggs of land birds, in respect to size, are more in proportion to the size of the bird, than those of aquatic birds. The standard yield and weight of eggs for the different varieties of domestic fowl is about as follows:—

Light Brahmas and partridge Cochins, eggs 7 to the pound; they lay, according to treatment and keeping, from 80 to 100 per annum, oftentimes more if kept well. Dark Brahmas, 8 to the pound, and about 70 per annum. Black, white, and buff Cochins, 8 to the pound; 100 is a large yield per annum. Plymouth Rocks, 8 to the pound, lay 100 per annum. Houdans, 8 to the pound, lay

150 per annum; non-sitters. La Fleche, 7 to the pound, lay 130 per annum; non-sitters. Black Spanish, 7 to the pound, lay 150 per annum. Dominiques, 9 to the pound, lay 130 per annum. Game fowl, 9 to the pound, lay 130 per annum. Crevecœurs, 7 to the pound, lay 150 per annum. Leghorns, 9 to the pound, lay from 150 to 200 per annum. Hamburgs, 9 to the pound, lay 170 per annum. Polish, 9 to the pound, lay 150 per annum. Bantams, 16 to the pound, lay 60 per annum. Turkeys, eggs 5 to the pound, lay from 30 to 60 per annum. Ducks' eggs vary greatly with different species, but from 5 to 6 to the pound, and from 14 to 28 per annum, according to age and keeping. Geese, 4 to the pound, lay 20 per annum. Guinea fowls, 11 to the pound, lay 60 per annum. Large eggs have generally a thicker shell than small ones.

Hens' eggs show remarkable difference in size according to the race. In the markets of France, the largest come from Normandy, the smallest from Picardy, the average or mean from Flanders. It is, therefore, not surprising to find that the price of eggs varies with the district from whence they come. Here are the current prices which ruled a few years ago, per thousand, from different localities:—

Prices in 1881.

Normandy	70 to 80 francs.
Brie	70 to 80 ,,
Touraine (large) ..	68 to 76 ,,
Beauce............	76 to 82 ,,
Orne	70 to 78 ,,
Picardy	70 to 76 ,,
Chatelherault	68 to 72 ,,
Burgundy	70 to 76 ,,
Champagne	70 to 74 ,,
Nivernais..........	64 to 68 ,,
Bourbonnais	64 to 68 ,,
Brittany	60 to 66 ,,
La Vendée	62 to 68 ,,
Auvergne..........	60 to 68 ,,
South of France....	64 to 70 ,,

Weight of Eggs.—The weight of eggs varies not only with the species of bird, but also with the breed or race, and, of course, with the size of the eggs. That of the ostrich equals 22 hens' eggs. Buffon states that hens' eggs weigh ordinarily 44·61 grammes. M. Dumas puts it at 58·50 grammes. M. De Lavison, from numerous weights of eggs of large races of indigenous and exotic fowls, kept in the Paris Garden of Acclimatisation, deduced 60 to 67 grammes as the weight. The largest, however, he met with were those of some Perigord fowls, reared at Compiègne, some of which weighed 120 and 140 grammes, without having double yolks. The Crevecour fowls generally lay eggs weighing 80 grammes. By comparison with eggs in former times, those of improved breeds of fowls of the present day have gained one-third in weight.

In a course of lectures on Oology given at the Gardens of the Paris Society of Acclimatisation, in 1861 and 1862, by M. Rufz, he demonstrated, from a variety of tests which he had made on the eggs of numbers of fowls, that the average weight is 66 grammes, while they were formerly stated by Buffon to be but 44 grammes, which makes it clear that eggs, like the ears of wheat of to-day, are larger, and as a consequence more nutritive, than formerly; an improvement to be attributed to the attention paid now-a-days to the raising of fowls, and to the crossing of indigenous races with foreign races of a stronger and more hardy character.

Exceptionally large hens' eggs are often met with. Thus in the journal *Land and Water* for June 16, 1877, a Cochin China fowl's egg is recorded, which weighed ¼lb. and measured 8 and ⅝ inches lengthwise, 6½ inches in circumference. That of a Dorking weighing 7 ozs., measured 7½ inches round the middle and 9½ inches across the ends. Another weighed 10½ ounces, and measured 8 inches round the centre and 12½ inches across the ends.

In the same paper, June 9, 1877, another Cochin China egg is mentioned, weighing ¼lb. which measured 7 inches in circumference, and from end to end 7¾ inches. An ordinary hen's egg measures 5 inches round and 2½ inches long.

A hen of the blue Spanish breed, belonging to Mr. John Oliver, shipwright, Blyth, is recorded to have laid an egg weighing 5 ounces, which measured lengthwise 4½ inches, and across and round the broad end, 6½ inches.

In the *Birmingham Mercury* of May 9, 1857:—

"A half-bred Cochin China hen belonging to Mr. Campbell, carter, of Great Croft-street, Darlaston, is stated during the past few weeks to have laid eleven extraordinary eggs of an enormous size, each weighing upwards of five ounces, and one when just laid weighed not less than seven ounces. On one being broken another perfect egg, of the usual size, was found inside, which led to seven being broken with the same results. Around the one weighing seven ounces (being the tenth egg) a third shell and egg had begun to form. Several of these

eggs are whole, and by carefully handling them the motion of the inner eggs may be perceived. Two of the inner eggs are also preserved, and numbers of people have been to see them, and have expressed themselves highly gratified at such an extraordinary phenomenon. The hen is not above the middle size, being about four and a half pounds in weight."

The *Mark Lane Express* of May, 22, 1882, also records a similar instance:—

"A young hen, belonging to Mrs. Relph, of Yarm, laid an egg recently measuring $9\frac{1}{2}$ inches by $7\frac{3}{8}$ inches, and weighing $6\frac{3}{4}$ ounces. After the shell was broken and the 'white' taken out, a perfect egg was found inside the yolk, with shell, white and yolk complete. The inside egg measured $6\frac{1}{4}$ by $5\frac{1}{2}$ inches."

Egg Shells.—The shell of all eggs is studded with small orifices, which are the means of absorption and exhalation by which the little animal in the egg respires. On this knowledge are grounded all the methods of preserving the egg by closing the pores. These pores are more or less visible according to the species of egg. They are very apparent in the egg of the ostrich, and scarcely visible to the naked eye in other species, but their functions are no less active. Many eggs are laid naked, dry, and smooth; others are impregnated with a greasy or glutinous substance. The latter are chiefly those of sea-birds, or those which live in moist localities. This glutinous coating is doubtless intended to preserve the eggs from the water, or to maintain the degree of heat necessary to preserve life. There are soft eggs laid entirely without shells, or with only the albuminous inner membrane. This occurs chiefly in hens that are too fat; and this failing can be remedied by supplying calcareous substances with their food.

Egg-shell is much used in medical prescriptions. When calcined at a low red heat the shells afford a very pure form of carbonate of lime. The principal use of egg-shells is, however, when blown, for the cabinets of private ornithological collections and those of public museums. The eggs of the ostrich are often mounted in silver, and form elegant drinking cups; so are the handsome green eggs of the Australian emeu, which look as if made of dark morocco leather. Ostrich egg-shells serve as water vessels among the African women; necklaces made of pieces of egg-shells punched out in a circular form are worn by some African natives.

Eggs blown are sometimes used in shooting galleries, strung as a mark or target. The smooth surface of the egg-shell can even be used for artistic purposes, and we often see ostrich eggs and hens' eggs painted or engraved with fanciful designs.

The employment of egg-shells for ornamental purposes is extremely ancient. A MS. in the Harleian collection represents a number of egg-shells ornamented in the most elegant and costly manner; miniatures were often painted upon them with extreme care, and egg-shells thus curiously decorated became valuable and highly esteemed presents. In Venice young noblemen frequently lavished large sums of money upon portraits painted within egg-shells, intended as presents.

Colour of Eggs.—Those who have only seen the ordinary fowl's eggs of our shops and poultry-yards, would suppose that eggs were always white. But on examining a large collection of birds' eggs, it will be found that they are of all colours. Except, perhaps, some very clear shades, the yellow for instance, none are wanting. There are blue eggs, yellowish, green, reddish, and olive. When we consider the eggs of some 9,000 different birds known, we find that not one-fifth of those of the European birds are white, and among the exotic birds, the number of white is much less. The white colour is not always pure, there are grey and yellow shades, more or less of a dirty hue. In coloured eggs, there are uniform colours and spotted colours. Although the larger number of the races of domestic fowls lay white eggs, there are some which have a yellow or nankeen tint, these are principally Asiatic birds. Birds which build open nests seem uniformly to have coloured eggs, and those which possess concealed or covered nests, white eggs.

With all our enormous consumption of eggs as food, it is extraordinary how little we know about them, and of their manifold uses—nutritious, medical and scientific, to which they may be put.

Chemistry of the Egg.—But few of those who break the shells of the cooked eggs of our common domestic fowls at the breakfast table, ever think of the wonderful nature of the structure they crush, or of the complex chemical nature of the contents consumed as food.

Before proceeding to inquire into the interior composition of the egg, we will consider the exterior covering, or the shell, the physical and chemical structure of which is exceedingly interesting and wonderful. The white, fragile cortex called the shell, com-

posed of mineral matter, is not the tight, compact covering which it appears to be, for, as stated above, it is everywhere perforated with a multitude of holes. Under the microscope the shell appears like a sieve, or it more closely resembles the white perforated paper sold by stationers. Through these holes there is constant evaporation going on, so that an egg, from the day that it is dropped by the hen to the moment when it is consumed, is losing weight and diminishing in volume. This process goes on much more rapidly in hot weather than in cold, and consequently perfect eggs are not so readily procured in summer as in winter. If by any means we stop this evaporative process, the egg remains sound and good for a great length of time. The substance used to stop transpiration must not be soluble in watery fluids, or liable to be readily removed. By chemical agencies, that is, by actually filling up the little holes in the shell by lime placed in contact in solution, eggs may be preserved for months and even years in a sweet condition.

The shell of the egg is lined upon its interior everywhere, with a very thin but pretty tough membrane, which, dividing at or very near the obtuse end, forms a small bag which is filled with air. In new-laid eggs this follicle appears very small, but it becomes larger when the egg is kept. In breaking an egg this membrane is removed with the shell, to which it adheres, and therefore is regarded as a part of it, which it is not.

The shell proper is made up mostly of earthy materials. The proportions vary according to the food of the bird, but 90 to 97 per cent. is carbonate of lime. The remainder is composed of two to five per cent. of animal matter, and one to five of phosphate of lime and magnesia. Now, where does the hen procure the carbonate of lime with which to form the shell? If we confine fowls in a room, and feed them with any of the cereal grains, excluding all sand, dust, or earthy matter, they will go on for a time and lay eggs, each one having a perfect shell, made up of the same calcareous elements. Vauquelin, the distinguished chemist, shut up a hen ten days, and fed her exclusively upon oats, of which she consumed 7,474 grains in weight. During this time four eggs were laid, the shells of which weighed nearly 409 grains; of this amount 276 grains was carbonate of lime, 17½ phosphate of lime, and 10 gluten. But there is only a little carbonate of lime in oats, and from whence could this 409 grains of the rocky material have been derived? The answer to this question opens up some of the most curious and wonderful facts connected with animal chemistry. The body of a bird, like that of a man, is but a piece of chemical apparatus, made capable of transforming hard and fixed substances into others of a very unlike nature. In oats there is contained phosphate of lime, with an abundance of silica, and the stomach and assimilating organs of the bird are made capable of decomposing or rending asunder the lime salt, and forming with the silica a silicate of lime. This new body is itself made to undergo decomposition, and the base is combined with carbonic acid, forming carbonate of lime. The carbonic acid is probably derived from the atmosphere, or more directly perhaps from the blood. These chemical changes among hard inorganic bodies are certainly wonderful when we reflect that they are brought about in the delicate organs of a comparatively feeble bird, under the influence of animal heat and the vital forces. They embrace a series of decomposing and re-composing operations which it is difficult to imitate in the laboratory. In the experiment to which allusion has been made, the amount of earthy material found in the eggs and the excrement of the hen exceeded that contained in the food she consumed. This seems paradoxical, and can only be explained upon the ground that birds as well as animals have the power, in times of exigency, of drawing upon their own bodies for material which is required to perform necessary functions.

The shell of an ordinary sized hen's egg weighs about 106 grains, that is, the inorganic portion of it; and if a bird lays 100 eggs in a year, she produces about 22 ounces of nearly pure carbonate of lime in that period of time.

If a farmer has a flock of 100 hens they produce in egg-shells about 137 pounds of chalk annually; and yet not a pound of the substance, or perhaps not even an ounce, exists around the farmhouse within the circuit of their feeding grounds. The materials of the manufacture are found in the food consumed, and in the sand, pebble-stones, brick-dust, bits of bones, &c., which hens and other birds are continually picking from the earth. The instinct is keen for these apparently innutritious and refractory substances, and they are devoured with as eager a relish as the cereal grains or insects. If hens are confined to barns or outbuildings, it is obvious that the

egg-producing machinery cannot be kept long in action, unless the materials for the shell are supplied in ample abundance.

Within the shell the animal portion of the egg is found, which consists of a viscous colourless liquid called albumen, or the *white*, and a yellow globular mass called the vitellus, or *yolk*. The white of the egg consists of two parts, each of which is enveloped in distinct membranes. The outer bag of albumen, next the shell, is quite a thin watery body, while the next which invests the yolk is heavy and thick. But few housekeepers who break eggs ever distinguish between the two whites, or know of their existence even. Each has its appropriate office to fulfil during the process of incubation or hatching, and one acts, in the mysterious process, as important a part as the other. The composition of a fresh egg, inclusive of the shell, may be taken to be as follows :—

Water	74	parts.
Albumen	14	,,
Oil or fat	10·5	,,
Mineral salts	1·5	,,
	100	

The yolk contains water and albumen, but associated with these is quite a large number of mineral and other substances, which render it very complex in composition. The bright yellow colour is due to a peculiar fat or oil, which is capable of reflecting the yellow rays of light, and this holds the sulphur and phosphorus which abound in the egg. If the yolk be removed and dried, and the yellow oil separated, it will be found to form two-thirds of the substance. The whole weight in its natural state is about 300 grains, of which three-fifths is water; of the white, more than three-quarters is water.

It is well known that from the egg all the constituent parts of the young animal are found—its skeleton, as well as its various soft textures. Now for the construction of the skeleton an amount of earthy matter is required which does not exist preformed in the soft contents of the egg, but has to be drawn from the shell. During the process of incubation, with the co-operation of the atmospheric air which permeates the shell, it appears that the phosphorus present in the yolk gradually undergoes oxidation, and becomes converted into phosphoric acid. This acts upon and dissolves the carbonate of lime belonging to the shell, which thus, as incubation proceeds, becomes thinner and thinner.

Dr. Pavy tells us that the yolk of the egg forms a kind of yellow emulsion. All the fatty matter is accumulated in this portion of it, and amounts to 30 per cent. The fat is held in suspension or emulsified by the albuminous matter of the yolk, which constitutes a slight modification of that of the white. The yolk contains relatively a less proportion of nitrogenous matter than the white. The proportion of solid matter on account of the fat is considerably greater. An enveloping membrane or bag surrounds the yolk, and keeps the fluid matter of which it is composed together. Being lighter than the white, it floats to that portion of the egg which is uppermost, but is kept in position between the two extremities by two processes of inspissated albumen, called *chalazea*, which pass to and are attached—one to either end of the egg.

In an alimentary point of view, therefore, the white and yolk differ markedly from each other, the one being mainly a simple solution of albumen, the other a solution of a modified form of albumen, associated with a considerable quantity of fat.

An egg weighing 1¾ ounces consists of 120 grains of carbon and 17¾ grains of nitrogen, or 15·25 per cent. of carbon and 2 per cent. of nitrogen.

According to the same authority, the average weight of an egg is about two ounces avoirdupois, and the quantity of dry and solid matter contained in it amounts to about 200 grains. It is composed of shell, white, and yolk, and in 100 parts about 10 consists of shell, 60 of white, and 30 of yolk.

	Entire contents.	White.	Yolk.
Nitrogenous matter	14·0	20·4	16·0
Fatty ,,	10·5	—	30·7
Saline ,,	1·5	1·6	1·3
Water	74·0	78·0	52·0
	100	100	100

The white of egg, as this shows, contains a considerably larger proportion of water than the yolk. It contains no fatty matter, but consists mainly of albumen in a dissolved state, and enclosed within very thin-walled cells. It is this arrangement which gives to the white of egg its ropy, gelatinous state. Thoroughly shaking or beating it up with water breaks the cells, and removes the ropy state.

The composition of an egg will be found, then, to consist of four distinct parts, viz., 1. The shell, or external coating. 2. The

inner membrane, which is strong and white, and possesses the usual characters of animal substances. 3. The albumen, or white of egg, is a coagulable lymph in its purest natural state, convertible by the action of heat, at about 134° Fahrenheit, into thin white fibres, and at 160° into a solid mass. In a heat not exceeding 212° it dries, shrinks, and assumes the appearance of horn. When burnt, it emits ammonia, and when treated with nitric acid, yields nitrogen. It is likewise remarkable for the property of rendering leather supple, for which reason a solution of white of eggs in water is much used by the leather dresser, and also for glazing cards; likewise with an admixture of alum forms the foundation of "adhesive cements" for fractured glass, &c. 4. The yolk, an oily substance, united with a portion of serous matter sufficient to render it diffusible in cold water, in the form of an emulsion and concrescible by heat. It is used as a medium for rendering resins and oils diffusible in water, and when roasted, the serous part of its fluidity being separated by expression, yields a substance called "oil of eggs." The egg is most valuable as an article of commerce, owing to the quantity of albumen contained therein.

Miscellaneous Uses of Eggs.—Eggs are useful for many purposes besides food and hatching. The white of an egg has proved a most efficacious remedy for burns; seven or eight successive applications of this substance soothe the pain and effectually exclude the air from the burn. This simple remedy seems preferable to collodion, or even cotton. Extraordinary stories are told of the healing properties of an oil which is easily made of the yolks of fowls' eggs. It is in general use among the peasants of Southern Russia as a means of curing cuts, bruises, and scratches. When, as sometimes by accident, sulphate of copper, or corrosive poisons generally, are swallowed, the white of one or two eggs will neutralise the poison, and change the effect to that of a dose of calomel. Raw eggs have at all times been considered an excellent remedy for debility, on account of the phosphorus contained in them, as well as a preventive of jaundice in its more malignant form. The yolk is sometimes used as a convenient medium for forming an emulsion of the thick turpentines with water. These mixtures are used as enemata.

The Trade in Eggs.—In 1850 we only imported 105,500,000 foreign eggs; in 1860 this had risen to 167,500,000; in 1870 to 430,750,000; in 1880 to 747,500,000; and last year to over 1,035,000,000. When to this we add the Irish and British production, the great importance of this industry and of poultry breeding in general becomes apparent. Our consumption of foreign eggs alone is nearly 30 annually for each head of the population.

In England, fancy poultry are chiefly bred, setting aside turkeys and geese. Excepting in one or two districts, poultry-farming receives but little attention. Hence England depends mainly upon Ireland and France for her poultry and eggs. In France, the order is reversed. That country exports eggs to the value of £1,500,000 sterling. Famous for her poultry, France also sends away fat capons and pullets to a large amount. By the census of 1872, there were in France over 45,000,000 fowls, 3,500,000 ducks, and about the same number of geese, and 1,000,000 turkeys. It is to France, then, we must look for the principles upon which market poultry are produced, to suffice for home consumption and leave a large surplus for export, at a profit.

On the whole, taking into consideration that the foreign breeder reaps a large return by exporting eggs to England, notwithstanding the expenses of freight, profit of exporters, importers, dealers, &c., to which he has to submit, it is evident that the Englishman, who has so many advantages on his side, would find the raising of poultry most advantageous. It is further to be remembered that while French eggs are often sold in London at 16 a shilling, we seldom get much more than half that number of English eggs for the same money.

Like many articles of general consumption, eggs have risen in price. In 1854 they were sold as low as 4s. 6d. the 120. In 1856, they advanced to 5s. 8d. From 1869 to 1871 the price stood at 6s., then sprung up to 10s. in 1873. In 1885 the price was 7s.; it is now about 8s. wholesale—the selling price ranging from 9s. to 11s.

There was formerly a duty on foreign eggs, but this was reduced on the 8th June, 1853, from 10½d. to 4d. per long hundred, and subsequently altered to 8d. per cubic foot of the containing package, 200 eggs being estimated to be packed in one cubic foot. The duty was abolished in 1860, with a loss to the revenue of about £20,000 a year. The import of eggs from Ireland, of which I have no recent details, must be considerable, as the number of poultry kept there is 14,000,000, or double what it was forty years ago, and

Great Britain has only a couple of million more head of poultry than Ireland.

In 1869, it was stated that the consumption of eggs in Paris was about 138 per head of the population, or 251,887,812 per annum, and it was assumed that the individual consumption in the rest of France was double, because in the provinces eggs and milk are to be found on each table, day by day; hence this gives 10,002,743,320 eggs, or with the Paris consumption, 10,254,630,132 eggs, independent of those exported and kept for reproduction. This statement is, however, somewhat beyond the mark as tested by recent figures.

A French poultry journal, *The Poussin*, gave last year the following details:—

According to the latest census or returns, there are in France 43,858,780 fowls, of a value of—say, 2s. 6d. each—£5,482,374 10s. Each year a fifth of the stock is sold for the table, at an average price of 3s. each—£1,350,000. There remains, then, about 35 millions of fowls, who reproduce 101 million birds. Of that number, close upon 80 millions are sold at about 1s. 6d. each; that is, say, £6,000,000. Each year 21 millions are accounted for as follows—part in misfortunes in rearing, and part in replacing old birds in the poultry-yards.

Estimating 100 eggs per fowl each year, of the 35 millions above, and allowing 10 million eggs for hatching, we are left with a yearly production of nearly three thousand and a half million eggs, of a value of about nine millions sterling.

The above figures show that the 43,858,780 fowls first-named, by their reproduction, give—

In birds, a revenue of	£7,200,000
Their eggs ,, ,, ...	8,920,000
Or a grand total of, per year	£16,120,000.

The production and export of eggs furnishes an important industry, especially in the northern departments of France.

Eggs are sold in the markets of Paris in baskets which ought to contain 1,004 good eggs. These are counted at the wish of the buyer, by the official agent, who verifies the *déchut* on loss; also the size by passing them through a ring. The charges are 25 centimes per thousand for counting, 65 centimes for examination and 15 centimes for passing the ring; besides these charges, there are the octroi duties collected by the Municipality of Paris.

Twenty-five million dozens of eggs are sent to the New York market yearly, and according to the best estimates the United States produces 9,000,000,000 of eggs annually. The eggs received yearly in New York, according to one authority, reach over 500,000 barrels, valued at £1,800,000, and this is but one branch of the trade. It is said that Philadelphia consumes 80,000 dozen eggs a day. The receipts annually in Boston are over 6,500,000 dozen. Between four and six million dozen are annually exported from the States. The millions of dozens consumed throughout the States, without passing into dealers' hands, it is impossible to estimate. Canada supplies large numbers of eggs to the States.

In some years, six or seven millions of eggs are exported from Spain. About 6,540 cases are shipped monthly from Italy. In 1880, 50.250,000 were exported.

Average number of foreign eggs consumed per head of the population in the United Kingdom.

1872	16·63	1880	21·58
1873	20·52	1881	21·63
1874	20·94	1882	22·98
1875	22·56	1883	26·40
1876	22·68	1884	27·59
1877	22·36	1885	27·56
1878	23·08	1886	28·12
1879	22·34		

IMPORTS OF FOREIGN EGGS INTO THE UNITED KINGDOM.

Year.	Quantity.	Value.
		£
1854	—	228,650
1855	—	236,865
1856	117,230,600	278,422
1857	126,818,600	317,046
1858	134,685,000	303,617
1859	148,631,000	336,662
1860	167,695,400	478,658
1861	203,313,360	550,557
1862	232,321,200	593,813
1863	266,929,680	673,638
1864	335,298,240	835,028
1865	364,013,040	928,247
1866	438,878,880	1,105,653
1867	397,934,520	989,837
1868	383,969,040	1,009,285
1869	442,175,040	1,126,853
1870	430,842,240	1,102,080
1871	400,473,000	1,263,612
1872	531,591,720	1,762,600
1873	660,474,000	2,359,022
1874	680,552,280	2,433,134
1875	741,223,560	2,559,860

Year.	Quantity.	Value.
		£
1876	753,026,040	2,620,396
1877	751,185,600	2,473,377
1878	783,714,720	2,511,096
1879	766,707,840	2,295,720
1880	747,408,600	2,235,451
1881	756,719,160	2,322,390
1882	813,922,400	2,385,263
1883	940,436,000	2,732,055
1884	993,609,000	2,910,493
1885	1,002,788,000	2,931,273
1886	1,035,171,000	2,884,000

The export of eggs from France is shown in the following official return :—

Year.	Quantity. Kilogrammes.	Value. Francs.
1870	24,969,000	——
1872	22,673,000	30,600,000
1873	25,472,000	35,700,000
1874	29,090,000	37,800,000
1875	34,417,000	46,463,000
1876	32,722,000	45,800,000
1877	27,122,000	38,000,000
1878	26,394,000	35,632,000
1879	23,803,000	32,611,000
1880	21,414,000	29,979,000
1881	21,052,000	29,473,000
1882	19,611,000	28,436,000
1883	21,339,000	30,941,000
1884	20,873,000	30,266,000

Each kilogramme is calculated to be equal to 20 eggs.

Eggs as Food.—Six large eggs will weigh about a pound. As a flesh-producer, one pound of eggs thus is equal to one pound of beef. About one-third of the weight of an egg is solid nutriment, which is more than can be said of meat. There are no bones and tough pieces that have to be laid aside. Practically, an egg is animal food, and yet there is none of the disagreeable work of the butcher necessary to obtain it.

Eggs, at average prices, are amongst the cheapest and most nutritious articles of diet. Like milk, an egg is a complete food in itself, containing everything necessary for the development of a perfect animal. It is also easily digested, if not damaged in cooking. Indeed, there is no more concentrated and nourishing food than eggs. The albumen, oil, and saline matter, are, as in milk, in the right proportion for sustaining animal life.

The valuable or important salts are contained in the yolk, and hence this portion of the egg is the most useful in some forms of disease. A weakly person in whom nerve-force is deficient, and the blood impoverished, may take the yolk of eggs with advantage. The iron and phosphoric compounds are in a condition to be readily assimilated, and although homœopathic in quantity, nevertheless exert a marked influence on the system. The yolks of eggs, containing, as they do, less albumen, are not so injuriously affected by heat as the whites, and a hard-boiled yolk may be usually eaten by invalids without inconvenience.

A boiled egg, being easier of digestion than meat, supplies a means of graduating the amount of nourishment. The celebrated Guinod de Reynière, who consecrated his life to studying the delicacies of the table, affirms, in his *Almanach des Gourmands*, that eggs can be served in more than 600 ways, and a book is published in London by a French cook, which gives 150 recipes for cooking eggs. The feeble man who has regained strength by boiled eggs for several days, will continue the same comforting food when presented in the form of an omelette, which is one of the principal food preparations made with eggs.

The flavour of eggs is much influenced by the nature of the package, for they imbibe foreign odours with the greatest readiness. Eggs brought in the same ship as oranges become impregnated with the scent and flavour of the fruit. If the cases in which they are packed are made of green wood, the eggs will be ruined. The straw in which they are packed should also be perfectly dry, or it will ferment and communicate a fusty smell to the eggs.

Dr. C. E. Martin, in an article on "The Food of the Chinese" (Bullet. Soc. of Acclimatation, 1872, p. 612), tells us they are very fond of putrid or decomposed eggs, which they prepare as follows :—They place them a certain depth underground and leave them for ten or twelve months. The putrefaction proceeds slowly, and the sulphurous gas escapes by breaking the egg-shell, and there remains a kind of preserved albumen, of a greyish colour, of a not disagreeable flavour, as he testifies from having tasted them. These putrid eggs are not, however, always a success, as out of eight or ten there may not be three or four presentable or edible.

A raw egg beaten up in a glass of wine is recommended for vocalists for clearing their voice, and in cases of debility, and a spirit of eggs is sold which is said to be useful in impaired health or the infirmities of age, when vital energy is wanting, and as a specific for soreness of the throat.

The white of egg forms an albuminous solution, useful in diarrhœa of phlegmatic origin. To make this, beat up the white of four eggs and add a quart of water slowly, remove the froth formed, add sugar, a little orange water, and if necessary, a dozen drops of laudanum. This albumenised water is the best antidote to a great number of mineral poisons.

The phosphorus in the egg is very good for all those who have brain work to do. The sulphur in the yolk, as is well-known, acts chemically on silver spoons, turning them black, forming a sulphide of silver that cannot be removed without taking off the surface of silver, thus rapidly wearing the spoon away.

Easter Eggs.—Eggs, although of animal origin, are now allowed to be eaten by Catholics during Lent. But it was not always so ; formerly eggs never figured on the tables of the faithful during the fast. But on the Saturday previous to Easter, a great quantity of eggs held over for six weeks, were blessed and distributed among friends on Easter Sunday. They were dyed yellow, violet, and especially red, hence the origin of the red or Easter eggs. In the reigns of Louis XIV. and XV., after grand mass on Easter Sunday, pyramids of eggs gilded were taken to the cabinet of the king, who distributed them to his courtiers. This custom of Easter eggs is continued to the present time, although modified. Easter eggs are no longer blessed nor gilded to be offered to sovereigns, nor are they held over to Easter eve to receive brilliant colours. A fortnight before Easter, in the coffee-houses and beer-shops of Catholic cities, may be seen huge dishes of eggs of various colours, which are eaten by the customers with their beer. And in families, a hard egg is added to the salad, after removing the coloured shell.

The mutual presentation of coloured eggs at Easter by friends, continues in Russia, and all Catholic countries. Fowls' eggs variously coloured, and having flowers and other devices upon them, formed by the colouring matter being picked off, so as to expose the white shell of the egg, are a part of all the Malay entertainments in Borneo.

The eggs of the domestic fowl are the edible eggs *par excellence*, but many others can be utilised for food. The egg of the goose, which is larger, is inferior in quality; in districts where geese are bred they give, however, some benefit. The egg of the duck, with a smoother shell, smaller and less rounded, is of a greenish or dark white, the yolk is larger and of a deeper colour than that of other poultry eggs, and the white by cooking attains a consistence like transparent isinglass. The egg of the pea-fowl or guinea-hen has a thick and hard shell, flesh coloured ; the yolk is proportionably much larger than the white.

The common wild or grey lag goose is the origin of our domestic goose. It used to be common and bred in our fens in former years. The common goose begins to lay towards Candlemas, and lays from 9 to 11 eggs. If well fed, she will lay 35 to 40 eggs, and sometimes 50, if the eggs are removed and she is not allowed to set. The turkey-hen lays from 12 to 20 eggs, rather smaller than those of the goose, which are white, mixed with reddish or yellow freckles. They are very good in pastry, and mixed with fowls' eggs they improve omelettes.

The question whether fowls or ducks are the better investment for the production of eggs has to some extent been settled experimentally in Germany and France in favour of ducks. They laid more eggs than the fowls, and though they were rather smaller, they proved to be decidedly superior in nutritive material.

It may be doubted whether as much attention is paid in England to the production of eggs as the utility of the food demands, and particularly by the poor, to whom their value is a consideration. Efforts should be made to induce all persons conveniently circumstanced to keep hens and ducks, and there is reason to believe that ducks are more profitable than hens, having regard to the number and size of the eggs laid by them. The solid matter and the oil in a duck's egg exceeds that of a hen's egg by as much as one-fourth.

Salted eggs are a considerable article of food in the Indian Archipelago. This arises from the instinctive desire of the people of the East to add salt to their vegetable food. The principal eggs salted are ducks' eggs, which are plentiful, as thousands of ducks are raised in the Dutch and other settlements. The new-laid eggs are placed in a paste of equal parts of clay, crushed brick, and salt, in which they remain for two or three weeks till the salt has perfectly penetrated. They are boiled hard before eating. In the Moluccas and Celebes

they also salt the eggs of the Turnik, a species of Megapode.

Manufacturing Uses of Eggs.—Eggs, their dietetic use apart, are of great utility in many branches of industry. In some, as in confectionery, both the whites and yolks are used, but usually the two find separate applications. The whites are employed in calico printing, in photography, in gilding, in clarifying wines and liqueurs, and by the bookbinder on the leather previous to lettering or tooling.

It will thus be seen that there is a heavy drain on eggs for various manufacturing purposes. Many millions are used in France for clarifying wines. By this means a wholesome and nourishing article of food is taken away from public consumption, and its price considerably enhanced. The clarifying of wines in France requires annually (at the rate of four eggs per barrel) more than 80,000,000 of eggs. Bordeaux alone uses 15,000,000 for this purpose, and Paris, 5,000,000. To avoid this, certain kinds of fining powders are now beginning to be employed, by which wines may be clarified with equal facility and at a smaller expense, and these are sold to the extent of about £8,000. Photographers consume a great quantity of eggs, and egg albumen is used for other purposes.

Egg Albumen.—The preparation of photographic paper with salted albumen has become in many hands a large business of itself. Some idea of the quantity used may be found in the statement that in one establishment alone upwards of 2,000,000 eggs have been employed in the course of six months to furnish the requisite quantity of albumen.

In calico printing, for fixing certain colours, Alsace uses about 330,000 lbs. a year, representing 37,500,000 eggs, or the product of 250,000 hens.

The Bohemian and Moravian albumen houses have, besides the places where they carry on their manufacture, establishments in many other towns, where eggs are broken daily, and the yolks retailed for kitchen purposes. In this way the very best price is obtained for the yolks, which are turned to good account. The white of the eggs is collected and transported to the required manufactory for further use. As fresh eggs can only be procured in spring and summer, albumen manufacturers who wish to make during the year must lay in stores of eggs. To preserve these stores from injury, the following process is necessary:—The eggs are packed in wicker baskets, bricked up in pits, which are filled in with lime water. These pits are covered with planks, and protected in winter from the frost by heaps of straw and manure. In this way the eggs are kept fresh and uninjured for the object in view.

The high price of egg albumen, and the evils attending its use, led, soon after its introduction, to an effort to replace it by a cheaper and more suitable medium, and many materials have been experimentally tried for this purpose, but hitherto without superseding the use of egg albumen. Animal caseine and vegetable gluten were at first principally recommended as a successful substitute for albumen, but these two bodies and many other proposed substitutes, have failed to prove their durability. They even lack the properties peculiar to albumen alone, and essential to their employment as thickening mediums. Thirty years ago the Industrial Society of Mulhouse offered a prize of £400, for the discovery of a material or process for replacing albumen in this respect, in calico printing, but hitherto no one has been found to whom this prize could be awarded. Z. Leuchs, of Nuremberg, proposed, indeed, to utilise the immense quantities of roes of fishes caught in Norway and Sweden, which contain a considerable per-centage of animal albumen. His proposal, however, met with only a success *d'estime*, for A. Dollfus, who went to Norway at the instance of the Society, to make experiments on the spot, as to how far these roes could be employed for the manufacture of albumen, gave it his opinion that this preparation could not be practically carried out, as the albumen obtained was totally unfit for printing purposes. It resulted, in spite of numerous experiments, in the impossibility of preparing albumen free from the skin-like eggshells of the spawn. Leuchs was, indeed, rewarded for his idea with the Society's gold medal, but the high prize remains still to be awarded.

The yolks of eggs are in great demand for dressing the skins in glove making and calf kid leather. Messrs. Dent, at Worcester, use up a large quantity.

According to M. A. Mosselman, yolk of egg may be preserved for some time without losing its clearness or colour, and without acquiring any smell, by adding to it five per cent. of neutral sulphate of soda, either in a powder or concentrated solution.

At his establishment at Carentan (Manche) France, M. Mosselman prepares a preserved mucilage for the use of leather dressers, skin dyers, and others; it is limpid, of a fine colour, and has no odour. It was awarded a silver medal by the Society of Industry of Mulhouse some thirty years ago.

An albumen manufacturer in Krakau, Austria, sells yolk solid at 8d. per pound, and received for this a prize medal at the Vienna Exhibition in 1872.

An egg oil is obtained in Russia in large quantities, and of various qualities; the best, so fine as to far excel olive oil for cooking purposes. The less pure and very yellow qualities are chiefly used in the manufacture of the celebrated Kazan soap. Both of these products were shown at the London International Exhibition in 1862, and at subsequent Exhibitions. Neither the oil for cooking purposes nor the soap are sufficiently cheap for general use, they are consumed only by the wealthy classes, as luxuries, the soap being regarded chiefly in the light of a cosmetic, is a much valued addition to a Russian lady's toilet necessaries.

The yolk is also used for medicinal purposes. It was used in the middle ages for the painter's art, before the discovery of oil colours, as in the Chapter House at Westminster.

Testing Eggs.—The egg, whether to be used in culinary or pharmaceutical preparations, should be fresh. To determine this they should be examined by the light of a lamp. Fresh eggs are easily known by their transparency when held up to the light. By keeping they become cloudy, and when decidedly stale, a distinct, dark, cloud-like appearance is discernible opposite some portion of the shell. A little instrument is sold as an egg tester. It consists of a small square box, with a hole at the top to receive the egg, and another at one side to look into. By an arrangement of mirrors within, the state of the egg is seen when a strong light is thrown upon it, so as to be transmitted through. If the egg be fresh the image seen in the mirror is almost transparent, whilst if stale it is more or less dark.

In a dark cellar, under one of the markets in Paris, devoted to the sale of dairy produce, by the light of a candle, the troublesome operation of examining eggs is carried on, for not a single egg enters into consumption there without having been thus examined. It is to be regretted that similar official scrutiny is not practised on in London.

A simple way of determining the freshness of an egg is by placing the egg in a hole in a piece of cardboard, and holding it between the eye and the light of a candle or gas burner, and by its general transparency its quality can well be determined. A new laid egg will have no void, but after two days it will shrink away from the larger extremity, and the egg gradually becomes cloudy in the centre. Another simple mode is by placing the egg against the closed eyelid, and if the end of the egg is void it will feel warm, whereas if the egg is new laid it continues cold.

The following is an old recipe for testing the age of eggs. Dissolve a quarter of a pound of common salt in a quart of water. An egg put in this solution on the day it is laid will sink to the bottom; one a day old will not reach quite to the bottom of the vessel; an egg three days old will swim in the liquid; while one more than three days old will swim on the surface.

The specific gravity of a freshly laid egg is between 1·0784 and 1·0942. When exposed to the air it loses water, which is replaced by air, and loses about 0·0017 to 0·0018 per day in gravity. At the end of three weeks the specific gravity will not be over 1·05, and it is then nearly on the point of spoiling. When the specific gravity has fallen to 1·015 the egg shows signs of decay.

A way to tell bad eggs is to put them in a pail of water, and if good they will lie on their sides; if bad, they will stand on their small ends, the large end always uppermost, unless they have been shaken considerably, when they will stand either end up. Therefore, a bad egg can be told by the way it rests in water—always end up, never on its side. An egg that lies flat is good to eat, and can be depended on.

Preserving Eggs.—How to keep eggs is a problem that has attracted the attention of inquirers from the earliest times. Twenty or more processes are generally known, all of which give unsatisfactory and in complete results; a circumstance scarcely to be wondered at when the composition of an egg, and the various changes to which it is subjected by exposure to atmospheric influence, are taken into consideration.

The egg-shell is furnished with numerous pores, through which the water evaporates, the loss of aqueous contents thus sustained

being scarcely perceptible in the first week, more marked in the second, and of considerable interest in the third. The surrounding atmospheric air takes the place of the water that has evaporated, and oxygenates the contents of the shell, which then commence to ferment and are speedily spoiled.

To hinder this evaporation, and so aid the preservation of eggs, they are often steeped for twelve hours in lime water, by which means molecules of lime are deposited on the shell, and so obstruct its pores to some extent.

Much scientific attention has been devoted in France to the preservation of eggs. The leading principle of all processes is the protection of the interior of the egg from the action of the atmosphere, and consequently it has long been settled that only the freshest eggs are eligible for preservation. To the solution of the problem of how to prevent the air from penetrating the shell of the egg, the experiments of such eminent *savants* as Musschenbroek, Réaumur, and Nollet, have greatly contributed. They all agree that the most practicable method is to envelop the new-laid egg in a light coating of some impermeable substance, such as wax, tallow, oil, or a mixture of wax and olive oil, or of olive oil and tallow. Réaumur suggested an alcoholic solution of resin, or a thick solution of gelatine. Nollet experimented successfully with india-rubber, collodion, and various kinds of varnish. Cadet de Vaux suggested the plunging of eggs for twenty seconds in boiling water, in order to coagulate that portion of the albumen nearest the shell, and then to pack them in vessels half filled with sifted cinders. This process—which, by the bye, has been well known in some parts of Scotland for many years—yields excellent results, but if neglected for but a second or two, the eggs are liable to harden. On the other side of the channel, "limed" eggs are never eaten *à la coque*, but only in the shape of omelettes, &c. Some preservers claim to obtain better results, as far as the taste of the egg is concerned, by substituting ordinary salt for lime. The solution, it is said, penetrates the shell, and so acts on the organic matter as to diminish its susceptibility to decomposition. The eggs are immersed during several hours. For home consumption, the French peasantry have for ages preserved their eggs in a very simple fashion. They take a wooden case, or a large barrel, and pack them in thick layers of sawdust, fine sand, chalk, bran, cinders, or coal dust, so that they do not touch each other. In the Maritime Provinces, the peasants use layers of ashes moistened with salt water. Both these processes are successful.

Another system recommended is found to answer extremely well. The eggs are placed for an hour in a solution of 50 grammes of salicylic acid and a little spirits of wine, diluted with a quart of water, and afterwards packed away in bran in the cellar. At the end of three months they were found in a perfect condition, and as well flavoured as if just fresh laid.

The late Dr. F. Crace-Calvert found by experiment the following results in the action of different substances in the preservation of eggs:—In dry oxygen gas eggs are unaffected unless punctured—moist oxygen decomposes the eggs. In moist hydrogen or nitrogen, eggs will keep three months. Eggs, pierced or whole, are perfectly preserved in carbonic acid, dry or moist. In chlorine water (1 to 500), eggs kept eight months in a closed vessel; in a solution of dilute chloride of lime, eggs would not keep two days; lime water and sulphate of lime kept them a little longer; carbolic acid (1 to 500) preserved them about six weeks. Eggs immersed in an iodide of calcium solution, were, after a month, not to be distinguished by smell or taste from perfectly fresh eggs.

Mr. Durand, a chemist at Blois, steeps them in a solution of silicate of potash. This being very viscous, is kept liquid by adding warm water. The eggs are placed in a vessel containing the silicate and afterwards dried; then the part upon which the egg rested is covered, because the silicate may have fallen off at this place. When each egg is completely covered all over, the eggs are placed in any receptacle, and may be left for a year if necessary, without any fear of their spoiling.

At the Dairy Products Show at the Agricultural-hall in 1884, three prizes were awarded for eggs preserved in the following manner:—

1st. Eggs which had been dipped twice in a solution of gum arabic and then dried, enveloped in paper, and kept in bran.

2nd. Eggs which had been rubbed with lard and then kept in dry salt.

3rd. Eggs coated with a composition of mutton and beef suet, and then wiped with a dry cloth.

The difficulty of transport and the heavy per-centage of loss from breakage and decay continue to raise the price of eggs to the consumer. With a view to utilising in a more portable and consequently cheaper form the

large supply of eggs obtainable in Austria, Messrs. Effner and Co. started a factory at Passau, in Bavaria, for condensing them. The eggs are carefully selected and dried, then reduced to a fine meal, and packed in tins ready for use. Although it is scarcely probable that the condensed egg can ever replace new-laid eggs for breakfast, it is asserted that a good omelette, as also the finest pastry, may be prepared from the product.

All previous methods are applicable only to the preservation of eggs intended for ordinary domestic use, and are of no avail for military or naval purposes, or for distant and prolonged travels. The new system of Herr von Effner differs essentially from all these methods. The problem proposed to himself for solution by Herr von Effner was how to preserve an egg, or its substance, by eliminating everything likely to promote decomposition, while entirely retaining its flavour and its nutritive properties.

The ordinary egg-powder was known long before. In 1814 or 1815, Gay-Lussac had succeeded in preparing such a powder, which he mentions in his *Traité de Chimie*, as a medium for the clarification of wines far preferable to the blood powders then in general use for that purpose. In 1856, M. Turgar constructed an apparatus by means of which he reduced eggs to powder, but, unfortunately, his invention met with little success, and his discovery was soon forgotten. Herr von Effner resumed the work that Turgar had begun, and has succeeded in producing a preparation of eggs in the form of a flour, which completely supplies the place of the natural egg in its nutritive properties. This he effects by driving off everything that could induce decomposition—that is to say, by effectually eliminating the water, by evaporating the 78 per cent. contained in the white and the 52 per cent. in the yolk of the fresh-laid egg.

Wild Birds' Eggs.—The eggs of wild birds are not very generally eaten in this country, but in some localities those of sea fowl are largely consumed, and a considerable trade is carried on in gulls' eggs on many of our coasts.

There is a great demand for Plovers' eggs in the city markets, for epicures. They are the eggs of the lapwing (*Vanellus cristatus*), a bird which lays about four eggs of an olive cast, spotted with black. These eggs come chiefly from Holland, the home produce being now very small, and they are received during the spring and summer, from March to June.

Mr. Yarrell, who wrote many years ago, mentions that 200 dozens of peewits' eggs were sent in one season from Romney Marsh to London. The eggs of many other species of birds are imposed upon the Londoners in the place of plovers' eggs.

The eggs of the domesticated Ostrich are too valuable at present to be given up for the table, but in Africa they frequently form a considerable item in the bushman's cuisine, and are esteemed by the hunters. When a nest is met with, it is often difficult to know how to carry away the eggs, and frequently the jacket or the pantaloons are taken off to form a temporary sack.

The ostrich will lay, during the course of the year, about 50 eggs, of an average weight of over 3 lb, which would represent nearly 1,000 eggs of the Spanish fowl. The eggs have a taste somewhat less delicate than those of domestic poultry, but are, nevertheless, perfectly eatable. The approved method of cooking is to place the egg upright on the fire, break a hole in the top, through which a forked stick is forced. This is made to rotate by rubbing with the hands, and so beats up the contents while cooking. It is stated that ostrich eggs will keep fresh and eatable for two or three months.

The topics with which I have had to deal are so numerous that it is impossible to touch upon artificial incubation, which is making such general progress. I may, however, state that in natural hatching the average number of ostriches raised is 16 out of 20 eggs, in artificial incubation, when properly managed, not more than one out of 12 eggs fail.

Two fundamental conditions are necessary for the normal evolution of eggs, a certain temperature, and the contact of the oxygen of the air with the germ.

The temperature necessary for the evolution, though probably the same for all warm-blooded animals, varies considerably with the species in the cold-blooded animals.

An important fact has been determined in the artificial hatching of fowls' eggs, viz., the complete suspension of manifestations of life by cooling, and the recovery when replaced in the heated incubators. This suspension of life plays an important *rôle* in pisciculture and sericulture, as the eggs may be frozen and yet not lose their vitality.

The eggs of the Australian Emu are nearly as large as those of the ostrich, but of a dark green colour. There appears to be always an odd number laid, some nests having 9 eggs,

some 11, and some 13. The eggs, although somewhat strong in flavour, are frequently eaten by settlers in the bush with great gusto, and are specially sought for by the natives.

The eggs of the *Rhea Americana* of Patagonia, although less delicate than those of the hen, are good eating, and are cooked in the cinders or as an omelet. They keep long without spoiling. They are yellowish white, smooth and polished, with a hard shell, rather elongated. A number of females seem to lay their eggs in the same nest, as from 30 to 50 are often found lying one upon another, tier upon tiers. These eggs form a staple commodity of food in the pampas of South America during the months of September, October, and November.

In France, M. Mercier had a rhea which laid this year six eggs at intervals of three days; the heaviest of these weighed 742½ grammes. When cooked, he found them to be excellent eating and savoury.

The kiwi *(Apteryx Mantelli)* of New Zealand lays an egg which weighs 14½ ounces, and the contents 13 ounces. The living bird weighs only 60 ounces, so that the weight of the egg appears to be nearly equal to one-fourth of the whole weight of the bird.

The native pheasant of Western Australia *(Leipoa ocellata)* deposits its eggs in a mound of sand, leaving them to be hatched by the heat of the sun's rays. The aborigines are very fond of the eggs, and rob the mounds twice or thrice in a season.

Other mound birds are the Megapodes.

The eggs of the Maleos, a kind of brush turkey of Australia and Celebes, are much sought after by the natives. The eggs are laid by different hens in one great mound, covered with earth and rubbish, and left to hatch by themselves.

Mr. Wallace, speaking of one place he visited, states :—

> Every year, the natives come for fifty miles round to obtain these eggs, which are esteemed a great delicacy, and when quite fresh are indeed delicious. They are richer than hens' eggs, and of a fine flavour; each one completely filled an ordinary tea-cup, and forms with bread and rice, a very good meal. The colour of the shell is a pale brick red, or very rarely pure white. They are elongated, very slightly smaller at one end, from four and a-half inches long, by two and a quarter to two and a half wide.

In the sea islands of Alaska, the eggs of the thick-billed Guillemot have an economic value, being the most palatable of all the varieties found in the islands, and hence are much sought after by the natives. The bird lays a single egg, large and very fancifully coloured. The shell is so tough that in gathering them they are thrown into tubs and baskets on the cliffs, and poured out upon the rocks with a single flap of the hand, just as a sack of potatoes would be emptied, and only a trifling loss is sustained from broken or crushed eggs.

On the Faro Islands, the number of eggs laid by the lesser black-backed gull, and sent annually to shore for culinary purposes, must be prodigious. The eggs of the common Guillemot lie there so close together, that it is difficult to move amongst them.

The dusky petrel (locally called the mutton bird) furnishes a rich harvest of eggs in the islands of Bass's Straits. About 300,000 have been taken in a single season from one rookery. The bird only lays one white egg, which is larger than a duck's egg, the average weight being about three and a half ounces. The flavour, like that of most sea-birds' eggs, is strong.

Incredible numbers of the common razor bill's eggs are collected on the coasts of Labrador, although the bird only lays one egg, which is disproportionately large, being three inches long; the colour is of a greenish white, irregularly marked with dark spots. The eggs of the different species of Terns are said to be excellent eating, and collecting them is quite a considerable trade. The eggs of the Albatross average about a pound in weight, and are esteemed by the sealers when they can get them.

In May and June the razor bills are numerous in the Western Islands, in Orkney and Shetland, and great quantities of their eggs are taken yearly at Bampton and Flamborough Head, which are their most favourite places of resort. A good take will be 200 or 300 eggs at a time. These find a ready sale at Bridlington and other places in the neighbourhood.

An enormous quantity of water fowl breed in Thibet. The natives collect their eggs for the markets of Jigatzi, Grantche and Llassa, along the banks of the Yani river, Ramchoo, and Yarbru and Dachen lakes.

The eggs of the Stork are very good eating, whether hot or cold. The natural colour of the cormorant's egg seems to be a bluish green, like the usual variety of the common domestic duck, but over this is a thick white irregular covering of lime, which is frequently in such abundant quantity as to stand out in

lumps on the surface, seldom allowing much of the original colour to be visible. No doubt this superabundance of lime is produced by the bones of the fish, of which this bird is said to eat prodigious quantities, and perhaps also from shell fish.

Reptiles' Eggs.

Turtles' eggs are held in great esteem wherever they are found, as well by Europeans as by others. They have a very soft shell, and are about the size of a pigeon's egg. The mother turtles lay three or four times a year, at intervals of two or three weeks. An experienced eye and hand are required to detect the eggs, as they are always ingeniously covered up with sand. The Orinoco and Amazon Indians obtain from these eggs a kind of clear, sweet oil, which they use instead of butter. In the month of February, when the high waters of the Orinoco have receded, millions of turtles come on shore to deposit their eggs. The certainty and abundance of the harvest is estimated by the acre. The yearly gathering about the mouth of the River Amazon alone is some 5,000 jars of oil, and it takes 5,000 eggs to make a jar.

The turtle comes at night, and deposits from 140 to 200 white eggs in the sand, carefully covering them up before returning to the sea. In about 14 days she returns again to the same place to lay, and will come up about four times before stopping laying, thus giving some 600 to 800 eggs.

A native of Brazil will consume as many as 20 or 30 turtles' eggs at a meal, and a European will eat a dozen at a breakfast. They make an excellent omelette. The Indians frequently eat them raw, mixed with their cassava flour.

The condition in which the egg of the turtle is best fit to be eaten is when taken from the slain animal, before the formation of the glaze and the surrounding parchment-like skin which answers the purpose of a shell. In this condition the young egg consists entirely of yolk, and hundreds in all stages of development, from the merest embryo upwards, may be found in the same individual. These imperfectly-formed eggs are very often preserved by drying, and are considered a great luxury,

In parts of India, and the Eastern Archipelago, the eggs of the turtle are salted in brine, or in humid sea sand; they always, however, remain soft, and may be kept fresh for a considerable time. The process is very simple, and only requires a little knack in knowing when the egg is sufficiently salted. The shell, being soft when put together with others, appears crumpled in all shapes.

The process of salting is this. The fresh egg is well shaken, and thus the yolk is broken, and the white and the yolk blend together. It is then rolled by the hand on a board with salt till the whole shell shows a marked difference in appearance. This is allowed to cool, and is then packed in fine salt. Eggs thus prepared are found to be plump, and, on opening them, of a pale yellow. From the fact of the contents all being shaken and mixed, they become of this uniform light colour, and not part yellow and part white, as eggs ordinarily are.

Some of the sandy shores of the islands about the east coast of Borneo abound with turtle eggs, which are collected by boats which go in search of them, and quite a large trade is the result, baskets full being always exposed for sale during the season in the shops at Sandakan. The island of Bergoar is the one most favoured by the turtles, and the season is during the continuance of the southern monsoon, viz., from April to October.

Serpents' Eggs.—The eggs of a large lizard (*Varanus vivitattus*) are eaten in Java. In the West Indies, the eggs of the Iguana are thought a delicacy. There are two or three of these lizards which are eaten, the *Iguana tuberculata* of the West Indies, *I. delicatissima* of tropical America, and *Cycleira acanthura*. One of these lizards will sometimes contain as many as four score eggs, about the size of a pigeon's egg, but with a soft shell, which when boiled, are like marrow. It would be a refreshing sight to see some aldermanic dignitary who has gone the round of all the dishes which native and foreign skill have been able to produce, partaking, for the first time of a dish of lizards' eggs garnished with anchovies.

The large eggs of the boa constrictor are regarded as a dainty by the Africans from the Congo. One of these snakes, killed on an estate in British Guiana in 1884, had fifty eggs, which were eaten by the negroes.

The eggs of the common teguexin (*Teius teguexin*), and of other large species of lizards, are eaten in South America.

In the Antilles and on the west coast of Africa, the eggs of the Alligator are eaten. They resemble in shape a hen's egg, but are larger, and have much the same taste. More than 100 eggs have been found in one alligator.

Fish Spawn.

By those who have not looked into the subject it would scarcely be conceived how extensive is the commerce, and how varied the uses of fish spawn.

Oviviparous animals, it is well known, are the most prolific, and of these fish excel all others. A small codfish will produce nearly two millions of eggs, and it is said that a single pair of herrings, if allowed to reproduce undisturbed, and multiply for twenty years, would not only supply the whole world with abundance of food, but would become inconveniently numerous.

Even the variety in shape and extent of production of fish ova is a curious subject of investigation. The eggs of various fishes differ remarkably in external appearance. Some would scarcely be believed to be eggs at all. Take, for instance, the skate's egg. It looks like a flattened leather purse, with four horns or handles at the corners. The yolk is in the shape of a walnut, larger or smaller according to the species. In the *Elasmobranchii*, sharks and rays, the ova are not so numerous as those of other fishes, the eggs being generally enclosed in coriaceous or leathery capsules, familiarly known to seaside visitors as mermaids' purses and the like.

The egg of the picked dogfish, the yolk of which is about the size of a pigeon's egg, is used by the inhabitants in parts of Sweden and Norway as a substitute for other eggs in their domestic economy. Cod roe is sold in London in a dried form, smoked, and thus darkly coloured. It is a delicious dish when partly salted, parboiled, and then fried. Cod roes are exported in tins to Australia and India in the salted state. The late Frank Buckland examined a cod roe weighing 7¾ lb., and found the average was 140 eggs to the grain. This gives 67,200 eggs to the ounce, so that in the whole mass of this one cod roe, allowing three-quarters of a pound for skin, membrane, &c., there was no less than 7,526,400 eggs. Dr. Day enlarges upon this estimate, and states that 11,000,000 of eggs have been taken from a 21 lb. codfish. 550,000 eggs have been found in a mackerel, 239,775 in a 4 lb. brill, while a salmon deposits about 800 for every pound weight of the parent fish. Frank Buckland tells us that salmon's eggs are not bad eating, the general flavour being not unlike that of a hard-roed herring. The roes of the okorune *(Perca fluviatilis)* and of the yerschi *(Accrina vulgaris)* are dried in ovens specially constructed for the purpose in Russia, and are used as a seasoning during Lent. The spawn of fish is sought for in the rivers of India, and made into cakes. The eggs of the kari *Labeo calbasu*) and kalmuri (*Diseognathus larnta*) are highly prized. The spawn of the silvery lavaret is sold in large quantities in the market of Helsingfors and other towns in Finland, and is very fine eating. The eggs (salted) of the Tainha fish of Brazil, which are found in innumerable shoals, are an article of commerce. Trombouk, a species of shad or herring, is much sought after in the East for its large roe, which is salted and dried.

France purchases yearly in Norway, cod-roe, or "rogue," as it is termed, to the value of £40,000, for bait in the sardine and anchovy fisheries, and Spain also buys in the same quarter. The barrel of salted roe, which costs only about £1 in Norway, is more than doubled in price by the time it reaches the French fishermen at Morbihan and Finisterre.

Caviare is the common name for a preparation of the dried spawn or salted roe of fish. The black caviare is made from the roe of sturgeon, and a single large fish will sometimes yield as much as 120 lbs. of roe. A cheaper and less prized red kind is obtained from the roe of the grey mullet, and some of the carp species, which are common in the rivers and on the shores of the Black Sea. It is of interest to Turkey and the Levant trade only. Caviare is principally consumed in Russia, Germany, and Italy, by the Greeks, during their long fasts, and also in small quantities in England. Inferior caviare is made into small dry cakes. 22,000 cwt. of caviare has been shipped from Taganrog in a single season, and from Astracan, about 30,000 barrels. The produce of caviare from the Caspian Sea, some years ago, was as much as 1,500,000 pounds. Caviare is found to possess 26 per cent. of nitrogenous matter.

Botargo is a preparation made on the coasts of the Mediteranean, of the ovaries full of the mature eggs of the mullet, *Mugil cephalus.* The eggs are salted, crushed, reduced to a paste, and then dried in the sun. Sometimes spices or other ingredients are added. Botargo is eaten like caviare, as a *hors d'œuvre*, and is consumed in large quantities in Italy, Greece, Corsica, and the south of France. The best is said to be made in Tunis, the exports there reaching in value £150 to £250 per annum.

Although the eggs of the salmon have no edible value, yet they have been of great im-

portance for transmission to Australia, to acclimatise the salmon in colonial rivers, and many hundreds of pounds have been spent in transporting salmon ova to the antipodes. A single salmon, weighing 20 lbs., will, in good condition, produce as many as 20,000 eggs, 90 per cent. of which, under favourable circumstances, will come to maturity. The eggs when laid are generally of a pinky opal colour, elastic to the touch, covered with a soft horny membrane, with a minute opening through which a particle of the sperm, the soft roe of the male, first enters, and the egg is fertilised. At the end of about 80 to 100 days from the deposition of the egg, the little fish is so increased in size that it bursts the shell and makes its *début* on the world of waters, in the shape of a narrow, semi-transparent, slip of flesh, with a misshapen head and a long tail. Speaking of fish spawn, mention may be made of a curious custom of the Chinese in pisciculture, given by P. Gresier, in his 4th vol. p. 5:—

They collect the eggs of fishes as they are found floating on the surface in rivers. These are placed in an empty egg-shell, and this is closed and placed under a setting hen with other eggs. When the little chickens are hatched, the egg-shells containing the fish spawn are emptied into the rivers, when the water is heated by the sun, and the young alevins soon thrive.

Although not probably an egg, yet mention may be made of the ovaries of some of the sea eggs, or sea urchins, of the class of Echinoderms, which, when fully developed, are collected as an article of food in Barbados, along the coast of Italy, and other quarters. In the Italian markets, near rocky coasts, may often be seen baskets of sea urchins, of which the following species are commonly eaten:—*Echinus melo*, *E. lividus*, *E. brevispinosus*, and *E. saxatilis*.

There is also a destruction by mankind of the ova or spawn of the Crustacea—lobsters, crabs, and shrimps, which are carried under their tail. The lobster produces from 25,000 to 40,000 eggs, the cray-fish upwards of 100,000. As much as six ounces of eggs can be taken off in May from a lobster weighing 3 to 3½ lbs,, and there are about 6,720 eggs in an ounce of lobster spawn. The lobster is never so good as when in the condition of a "berried hen." The eggs, like those of the female crab, are much in request among cooks for colouring sauces. The eggs of the king crab (*Limulus gigas*, or *moluccansis*), which are collected in large quantities, among other places on the north coast of Java, are considered a delicacy, and are eaten both fresh and salted. The spawn of fish, especially of the Indian herring, is also eaten there.

Insects' Eggs.

The eggs of some insects are eaten in Siam, Egypt, and Mexico, but those most valuable commercially are the eggs of the silk moth.

Silkworms' Eggs.—The trade in silkworms' eggs from Japan has become an extensive and profitable one. In 1868, £1,000,000 sterling was paid to Japan by the "graineurs" of Europe for silkworms' eggs. In 1869, 2,000,000 of cards, costing on an average 12s. 6d. each, were sent to Europe. In other years 3,000,000 of these cards, packed in cases of about 300, thickly studded with these tiny specks, have been shipped from Japan by the various steamers.

Between 1861 and 1871, over two million pounds' weight of silkworms' eggs, valued at nearly £5,400,000 sterling, were imported into France on cards.

In 1871, 2,200,000 cards of eggs were imported into Europe from Japan. In 1872, 1,500,000 cards were sent to Marseilles. Many more were required, but the Italian purchasers in Japan caused the largest part of the supply to find its way thence direct to Italy.

Long experience demonstrates that the more abundant are the eggs laid, and the less there are in a gramme—that is the heavier the eggs weigh—the more guarantee is there of success. Formerly, an ounce of eggs (or 31 grammes), about 36,000 eggs, would produce on an average, 80 or 100 lbs. of cocoons, now it will only yield about half that quantity, and sometimes scarcely 50 lbs.

In China and Japan, the moths are placed to lay their eggs on cardboard or thick paper, which they cover regularly and closely with a secretion which glues them to the spot and acts as a preservative from heat or other accidents. Hence the cards may be transported many thousands of miles safely, in a ship with a properly regulated temperature, so as to prevent their hatching too soon. They should be arranged, and the cards thickly covered, without being overlaid, and having no unpleasant smell. A first glance at one of these cards would lead one to suppose that the eggs were artificially attached to the card, but the regularity is obtained by careful management of the moths at the time of laying the eggs. A vigorous moth will

usually lay four or five hundred eggs, and those of Japan are more prolific than the European ones, although the eggs are smaller. One of these cards well covered will contain 50,000, so that it requires at least 100 moths to cover it. The moths are placed simultaneously on the cards, and when the laying is terminated, the peasants examine the cards, and if there are any vacant places, attach a moth by pins through its wings, so that the eggs may be deposited in the right place.

Hence arises that regularity of eggs on the card which excited such surprise among the silk breeders on their first arrival from the East.

The cards bear on their face a Japanese inscription, describing the character of the eggs, &c., which is written before the eggs are attached, and appear prominently afterwards through the transparent eggs. On the reverse of the card are official stamps, Japanese and consular, verifying the date and locality of production. Forgeries and alterations of these official brands, &c., are often made, and three hundred of the most prominent dealers in silkworms' eggs were on one occasion arrested by the authorities in Japan for this offence.

The silkworm's egg is the size of a pin's head. About 100 grammes of seed may be obtained from a kilogramme ($2\frac{1}{5}$ lbs.) of cocoons, composed of equal parts of male and female. The number of eggs contained in a gramme will vary from 1,200 to 1,500, according to the size of the race.

When first laid, the eggs are of a clear, jonquil yellow, and if they are fecund, will pass successively through a series of tints, till they arrive at their definite hue, an ashy grey; while, if not fecund, they will remain yellow. As the shell or covering is nearly transparent, these changes of colour, which are those of the germ which it encloses, may be successfully traced. The eggs should not be much depressed, and the colour regular or normal, of a greenish or bluish grey, according to the race of white or yellow cocoons; there should be an absence of red eggs, which is a sign of disease, and the intensity of which may be determined by weighing the eggs.

Special steamers are chartered to bring home this valuable cargo as speedily as possible; and during the voyage, in suitable weather, the boxes are opened and the contents ventilated. In each box, which is three feet long, and on which a freight of fifteen dollars is paid, are packed 200 cards in separate grooves, so as to allow of ventilation between each card, and to avoid friction. Each card contains about five-sixths of an ounce of eggs, and costs from three to four dollars in Japan. It is a matter of the greatest importance to export eggs as soon as possible after they have been laid, and before they have been exposed to any chill from cold weather, especially if they have to travel long distances.

One consignment, consisting of three cart-loads of eggs, valued at £1,200,000, arrived from San Francisco at New York. They consisted of 80 cases, weighing about 8,000 lbs. They had been shipped by the steamer *Gaelic* from Yokohama to San Francisco, transhipped by rail to New York, and from thence sent by the steamer *Baltic* to Liverpool. The North Pacific and North Atlantic route from China and Japan is rapidly increasing in favour over the old route, *viâ* Suez, as time is saved on the former, this shipment only occupying 46 days from Yokohama to Liverpool, including all detentions, the Pacific and Oriental time being 59 days.

DISCUSSION.

Mr. Lascelles-Scott said this subject was one well deserving of attention; for, as Mr. Simmonds had shown, not only were eggs very valuable as articles of food, but also in a commercial sense, and there was a vast amount of money which year by year passed from our hands into the hands of foreigners, a large proportion of which we might just as well keep ourselves. He was pleased to hear the suggestion that a great deal more might be done in the way of egg culture in this country, and it seemed to him that that Society, which had encouraged so many good things in Arts, Manufactures, and Commerce, would do well to emphasize what had been said by Mr. Simmonds, and do something in a practical way for the encouragement of egg culture. Mr. Simmonds spoke of the wonderful fertility of fowls, especially of the greater fertility of the domestic fowl as compared with wild birds. Some years ago, at Wolverhampton, he made some experiments in this direction, and found that by selecting his fowls he could obtain a much larger number of eggs than by taking them indiscriminately; and he might mention that he had one black Spanish hen which laid 307 eggs in one year, and several others were nearly as productive. Mr. Simmonds had certainly not over-stated the nutritive power of eggs, and it was quite right to call attention to ducks' eggs, whose nutritive value was about one quarter more than hens' eggs; and

it should also be borne in mind that the feeding of ducks was much cheaper. In this country we were not so favoured in point of weather as were our neighbours across the channel, and therefore the hatching of young chickens for the market was not carried on under such favourable circumstances; but by encouraging the use of artificial incubators, which were now brought to very great perfection, a larger per-centage might be hatched, and in this direction the Society might do good by publishing the results which had been attained. He had noticed that where a layer of eggs in an artificial incubator had been subjected to the influence of an electro-magnetic field, a greater proportion of eggs would be successfully hatched than under ordinary circumstances.

Mr. BROMHEAD said the last speaker had touched on a very important point when he said that in this country we were very much handicapped with regard to the rearing of poultry or eggs by the weather, or as he should prefer to call it, the climate. Birds of all kinds thrive much better in a warm climate, and perhaps the Chairman might be able to say something about the fertility of poultry in the Australian colonies. Where they had the advantage of a warm winter season, fowls could be kept cheaper and they laid with much greater regularity. They knew that in the winter season eggs were scarce, and he was told by some of his friends, who had experience in the matter, that the great secret of making hens lay all the year round was to keep their houses warm, and give them warm food. In our climate this involved a very considerable expense. At the present low price of grain, he thought it strange that eggs had not shown any inclination to a decrease in price. There had never been a time when the price of oats and barley had been so low, and this should be an incentive to agriculturists to grow poultry and send eggs to market. He hoped that when the allotment system came more into vogue more attention would be paid to this matter, notwithstanding the difficulties of the climate. The great cause of the success of the French peasant was that he had a small holding of land on which he could run his fowls, and he was not at all particular in letting them come into the house to roost in winter time, and sometimes even his stock shared the same sleeping accommodation as himself. He thought rather too much stress was laid upon ducks, for it was quite new to him to hear that they were more easily raised than fowls, and from what he had heard, they did not lay so many eggs. Mr. Lascelles-Scott had spoken of one hen laying over 300 eggs in one year, which would amount to something like 50 lbs. weight, a remarkable amount to come from one bird, weighing probably 8 or 10 lbs. This was a most amazing fact in natural history, and ought to make poultry raising popular and successful.

Mr. LOCOCK WEBB, Q.C., said that some time ago he got into his head the idea that he should like to keep what was called a cottage farm, and of course, rear poultry, and so on. It was a most delightful spot for the purpose, with a nice stream running through the grounds, and nothing could be better adapted for such an enterprise. He also thought that if he could do this successfully himself, there were a good many cotters in the neighbourhood, and they would probably follow his example, especially if the acre allotment system were carried out, which he hoped it would be largely throughout England. He had tried all sorts of experiments, but still wanted to learn more if he could. He tried oats, and thought he would grow a few oats as a cheap way of feeding his poultry, but he was told that would not do. Then he was recommended to use maize, and it was extraordinary how many sacks of maize he had to buy, barley meal, and other things, but the conclusion he came to was that he wanted further information how to to breed and rear poultry cheaply. He did not mean to say that he had lost money by it, but he had not made much; and he thought there was really an opening for an enormous industry in this country in eggs and poultry production. He quite agreed with the last speaker that fowls must be kept at a proper temperature, especially at night; this required houses, and when you had to have houses, unless you could get food cheaply, it was rather expensive work. He had seen how this industry was carried on in France and elsewhere, and that led him to make some inquiries as to the cost of railway carriage in this country, which he found rather an important item. In Calvados he had seen wagon loads of eggs, all going to the coast, and he could not understand how the French could send them here, as they had to undergo a considerable road traffic, then across the Channel from Cherbourg, probably to Southampton, on to London, and yet were they delivered cheaper in that market than they could be sent from Somersetshire. His notion was that it was an industry which would answer, and which was worth consideration.

The CHAIRMAN said they were much indebted to Mr. Simmonds for the admirable way in which he had brought forward a subject which might be of great importance to the poor of this country, especially to the farmers and agricultural labourers. One of the most valuable portions of the paper was that which dealt with eggs as an article of food, which could not be too widely known. Mr. Simmonds had not attempted to show how the industry could be carried on; that must come from others who had more practical acquaintance with the subject. The last speaker had alluded to the many difficulties in the way of producing eggs in England with profit, in consequence of the climate, but he thought that might be overcome, as others which seemed much more formidable, had been. In 1854, when he first undertook to send salmon eggs to the Antipodes, and hatch them when they got there, he was said to

be a lunatic, and that continued for ten years; but millions had now been sent out, and tens of thousands had been hatched. Out of the last shipment he made three years ago, 30,000 young salmon (*Salmo salar*) had been hatched in the ponds of Tasmania. The result had yet to be ascertained, but he had no doubt that in a few years the waters of Australia would be well stocked with the three best kinds of the *Salmonidæ*. Mr. Simmonds had referred to the freezing of eggs, and he might mention that that caused him more trouble than any other part of the experiment. A lady, at the dinner-table, when the subject was being discussed one day, said, "Why not freeze eggs, and send them out frozen, and hatch them when they get out there?" And the gentlemen who formed the committee with himself thought that would be a good plan. In every case, however, when they were frozen, either naturally or artificially, they were killed; and on looking at "Johnson's Dictionary," he found the meaning of "freeze" was to "kill by congelation." There was no doubt that the freezing of eggs destroyed their vitality, but it was quite true that by employing a low temperature they might be prevented from hatching for a long time; in one case he had kept them for 140 days, and they were successfully hatched afterwards. He concluded by proposing a vote of thanks to Mr. Simmonds, which was carried unanimously.

Correspondence.

ILLUMINATION FROM WASTE OILS.

I was extremely sorry that I was prevented through illness from being present during the discussion which followed on the reading of my paper, as some points were raised on which I would have liked to give more detailed information.

In reply to Mr. Doty, the oil which we principally employ is that obtained from the washing of blast furnace gases in the process for obtaining the ammonia which they contain. This oil is a partially oxidised compound, containing cresyl alcohol and other similar bodies in large quantities, resulting from the fact that the oil is formed by passing air and products of combustion of coal through the fuel in the upper part of the iron furnace. The oil does not, of course, give quite so high a duty as crude petroleum, as it is already, as it were, partially burned, whereas the petroleum is practically a pure hydrocarbon; but the Lucigen will burn almost anything which will flow from light oil or naphtha up to common crude tar. The latter is utilised at some gas works—as explained by Mr. Smith, in *Journal of Gas Lighting* of April 26th, 1887—by gently warming it, so as to make it sufficiently fluid.

As most of these crude oils have a very offensive odour, I gave instructions to fill the lamp used in the Society's Lecture-room with common paraffin oil, but of course that is never used in practice, nor does it give as much light as denser oil, but it was quite sufficient to explain the working of the apparatus.

I find that the use of steam in any form has a lowering effect on the luminosity of the flame, so I arrange the steam lamp so that a large volume of air is drawn in near the root of the flame, and the steam is only used in small quantity for the purely mechanical purpose of disintegrating the oil to form the fine spray.

The cost of the light given by the Lucigen is easily arrived at by actual photometric measurement, and as the price of gas is well known, the comparison can at once be made. Dr. Wallace, the analyst of Glasgow, made a careful test of the Lucigen with the following results:—

"The larger or ordinary lamp burned 2·245, or very nearly 2¼ gallons of oil per hour, giving a flame about three feet in height, the illuminating power of which I found to be 2,796 standard candles.

"These results show that the Lucigen is a very economical source of light for large spaces. The cost of 2¼ gallons of oil is barely 2d., and to obtain the same amount of illumination from 16-candle gas (at 2s. 6d. per 1,000 feet) would require 874 cubic feet, costing 2s. 2d., and from 25-candle gas (at 3s. 4d. per 1,000 feet) 559 feet, costing 1s. 10½d."

The objection raised that a shower of oil spray might be produced by the Lucigen, is one we have never met with in practice. The combustion is as complete and smokeless as any gas flame; but of course, if not properly regulated, or allowed to get clogged up with dirt, it is possible to make the Lucigen burn badly.

The Lucigen is already very successfully employed on board ship, and as the flame can be carried anywhere, it can be placed beyond the reach of any great body of water from a wave. Spray has no effect on it.

Of course, I did not put forward heating by oil, as more economical than coal when heat is required on a large scale, and where coal is cheap. But for the special purposes I have described in my paper, it is much more economical and more efficient than coal, and the industries I touched upon cover a large field.

Mr. Kimber's remarks on the sources of oil, and the future of the supply when the demand comes, are very encouraging, and express very much the conclusions I had myself arrived at. There is no need to fear any great rise in price, for even a very small and temporary rise will tempt people to go into the business of supplying the oil from the inexhaustible natural stores, which are as yet treated only in a retail manner.

In reply to Mr. Hilton, crude petroleum, both Russian and American, have been burned in the Lucigen with perfectly satisfactory results. These oils are the very best for the purpose, giving a very

intense white light, owing to their containing solid and dense hydrocarbons, just as naphthalene vapour increases the luminosity of a gas flame. Besides, they are free from water and accidental impurities incidental to creosote and waste oils.

There can be no explosion with the Lucigen, because the oil and air only mix on actually arriving at the point whence they issue to the atmosphere. Even naphtha can be used with perfect safety.

When the Lucigen is used for industrial purposes the noise is of no consequence, but when introduced for street lighting, the noise can be rendered almost inaudible by working at a lower pressure and enclosing the flame in a lantern. I have aimed at producing a flame of such stiffness as to withstand the strongest gales without a lantern, and such a flame must be under high pressure; hence the noise. A large lantern is expensive, and besides, it entails a strong post, and generally a more expensive plant, while I have aimed at cheapness. In street lighting, however, a lantern would be used even for the sake of appearance, and would allow of the flame being a soft one, as resistance to the wind would no longer be a requisite, the lantern giving protection. In this way the noise is abolished.

The amount of oil consumed varies of course with the size of the light, but a flame of 3,000 *actual* candle-power, equal to five or six electric arc lamps of 2,000 *nominal* candle-power, is maintained by the combustion of about two gallons of crnde oil per hour. That shown in the room was less than half that size.

J. W. Hannay.

Cove Castle, Loch Long.
5th Dec., 1887.

The subject of Mr. Hannay's paper is well worth being brought before the Society of Arts and discussed. The light is being used by different contractors on these works, and is most suitable for the various purposes for which it is employed, and where the noise and oily spray is not so objectionable. At a deep cutting, north of Wenvoe Tunnel, several lights are used for night work, and are connected with a pump to clear the tunnel of water, worked by compressed air. In a rock-cutting, south of the tunnel, the lights are connected with air compressers driving rock drills. At another place, where cast iron screw piles are being screwed into the ground with gearing driven by steam, the light is connected with a portable engine, the steam whistle being removed for the purpose. Until the steam issues dry from the apparatus, it does not readily catch light. In the apparatus there is a pipe carried through the tank for the purpose of heating the oil in case of frost, and is left slightly open. There are various kinds of lights used on these dock and railway works, including the electric light, but none are so economical as these new lights. Looking to the future, this matter is a most important one.

John Robinson.

Barry Dock and Railways,
Engineer's Office, Barry, Cardiff.
Dec. 6th, 1887.

Mr. John Beale, a member of the Society, writes drawing attention to the apparatus known as Beale's Air Light, which was patented by his father, Mr. J. T. Beale, in 1834. This apparatus was intended for burning mineral oils, and formed the subject of a lecture by Professor Faraday, at the Royal Institution. In this, as in the Lucigen, compressed air is used to form a jet of mixed air and oil, which is ignited. The oil is supplied to a burner from a reservoir, and the pipe through which the compressed air is supplied passes up the centre of the burner. It was proposed to use the light for burning in ordinary street lamps and for domestic illumination, compressed air being supplied through mains.

SANITARY SEWAGE AND WATER SUPPLY.

At the discussions last held at the Society on the sewage question, which I should have attended had my health permitted, erroneous statements were made by the supporters of the combined system, in answer to which I should then have submitted statements of experiences for their correction. At the recent Sanitary Congress at Vienna, and also at the Congress at Bolton, erroneous statements, as I deem them, of the same tenor have been made, which I consider it to be due in the interest of sanitary science to endeavour to correct.

In the first place, no perception is evinced in any of them of the great distinction for sanitation of sewage which is undecomposed, and the sewage in a condition of putrefaction—of sewage which feeds fish and of sewage which kills them; of sewage which, for agricultural purposes, is wasted by putrefaction, and of sewage which is unwasted by decomposition, which has generally about a third more of power for agricultural production. Nor do they recognise the value of fresh sewage as a means of removing the popular objections to sewage farms near towns in comparison with sewage that is putrefied, nor the results of bad drainage and of internal stagnation; nor that with sewage which is fresh that there is a reduction of the evils that arise from the common high culture with solid manure. The great principle laid down by De Candolle, the highest known vegetable physiologist of the last century, verified in practical examples, and cited in our instructions—"that the future of agriculture would be in the distribution of food and water at the same time"—is neglected. The proofs are overlooked that have appeared in various examples—that whilst the yield of ordinary agriculture is as one, that of the

extraordinary agriculture, the *marachere*, or market garden culture, is as three and a half, and the yield from the liquefied culture as five and more. Thus at Croydon, on the fields irrigated with fresh manure, five cows are fed where only one was formerly. An adjacent well-conducted example gives a sixfold yield from the fresh liquefied manure culture.

It is yet extensively put about against the direct application of fresh sewage to agricultural production that, as a rule, the utilisation of human excreta, either *per se* or in the form of sewage, is generally attended with very considerable loss, and that only in a very few cases has it been attended with a profit. Such statements denote very imperfect examinations, which would display the—extraneous—causes of loss from the application of the cheapest means of working. However, Professor Corfield, in his work on the utilisation of sewage, gives a table of the application of the sewage of sixteen towns, and states that, judging from the results of one year, after the repayment of capital for outlay in works connected with the sewage farms, in eleven farms out of sixteen there is a profit to the ratepayers. As respects London, that there should be any profit under the combined system adopted by the Vestries, would be a matter of surprise, when it is considered that of the water distributed, full three-fifths is distributed in pernicious waste in the production of excrement-sodden subsoils; and as to the water-closets, they are commonly constructed so as to consume two or three times the quantity of water that would suffice—altogether producing an extent of dilution that must render sewage worth little more than a fourth of its value under the separate system. At the time of our examination of the water supply of the metropolis in 1850, it was found that by the service of large Cornish engines of ninety-horse power, upwards of seventy thousand gallons was raised one hundred feet high for a working expense of one shilling. With the improvement recently made in steam-engines, it will be possible to raise nearly double that amount for one shilling. And why could not sewage be distributed at a like charge by the like power? As to the profits of sewage farming, tenants are not in the habit of considering that they are obliged to disclose them; indeed, they generally be-little them, from apprehended increase of their landlords' unearned increments. In the case of the tenant for the farm of the sewage of Aldershot, he gave it up because his lease was out, and because he came at the same time into an estate which demanded his immediate attention; but it was inferred at once and declared that he gave it up because it would not pay. He, however, assured me that although the soil was of a very barren description, yet with a superior though partly putrid sewage he had made a very fair profit out of the farm of ninety-six acres through his sixteen years' lease. As to towns, take the instance of Croydon. Under the mistaken notion that the sewage can only be distributed by gravitation on lands in immediate contiguity to the town, a rent of upwards of ten pounds an acre was exacted for land of which the ordinary rent was twenty-three shillings per acre.

In almost every case storm and subsoil water has been conveyed with the sewage, diluting, and thus reducing its manurial value, and increasing its volume at the time when the rain-sodden land was least adapted for its reception.

It has recently been put forth by a chemical advocate of the combined system, and of the metropolitan system of sewerage, that farmers reject town sewage. Now, before the Committee of the House of Commons on the sewage of the metropolis—1861—a practical agriculturist came with the engagements of the farmers of 20,000 acres in Essex and of 7,000 acres in Middlesex, to take the sewage if it could be supplied on proper terms and conditions.

As an example of the exactions on sewage farms, it may be mentioned that one city desired to obtain some land which rented at ten shillings an acre, but the Right Hon. Landlord exacted £4 per acre for his supposed monopoly of a site where it could be applied by gravitation. The average value of land was from twenty to thirty years' purchase, but 150 years' purchase have been charged by noble lords upon towns for the application of their sewage. In addition to such factitious charges are the excessive legal expense for obtaining the sanction of Parliament for local Acts for towns; expenses that would suffice for the construction of a large proportion of the really requisite works.

Where pipe distribution is used, plots of land should be tested by distribution by hand or water carts to determine its particular receptivity, and the extent of the pipeage has been largely increased, often to double the extent of what would have sufficed. And these defaults of want of skill and of competent science have been overlooked in the common allegation that sewage farms and liquefied manure farms do not pay. Nevertheless, it may be observed that although liquefied manure culture is a delicate culture, requiring the skill of the horticulturist, and is beyond the capacity of the common agriculturists, the yield of the common liquefied manure farms has been from ten to twenty bushels per acre beyond the yield of common agriculture. One detriment to the liquefied culture has frequently been that the highly superior quality of the produce has brought from game preserves, and from extraordinary long distances, rabbits and hares which the farmers were not allowed to kill.

Insanitary chemistry only proposes to treat "raw" sewage—"crude" sewage—that is to say, putrefied sewage, with expensive and really useless disinfectants. Such chemistry speaks of utilising the putrid sewage of 100 of the population on one acre of soil; sanitary science will now utilise the sewage of more than a hundred and fifty to the population for a greatly superior agricultural production on the same area.

The people of Paris have had no experience of any condition of sewage except that of putridity, and

hence are much opposed to sewage irrigation close to Paris. Even Dr. Jules Brocard, of the Academy of Medicine, who, in an able article in the "Revue des Deux Mondes," advocates the removal of the anarchy of local administration in France, and the adoption of the principle I proposed a long time ago, of a centralisation of a scientific administration for the people, in place of the centralisation they now have—even he gave no exposition of the economy of using sewage which is undecomposed and fresh. He has probably seen nothing of it, and knows no more of it than the people of Paris.

It will, I expect, be found that at the present time double the expense is being incurred for disinfecting the sewage made putrid by the combined system in our metropolis by throwing away the productive power for the sustenance of some two hundred thousand cows, as would suffice for the direct application of fresh sewage to the land, and maintaining conditions which the report of Lord Bramwell's commission has declared to be "a disgrace to the metropolis and to civilisation."

When stripped of factitious adjuncts, water carriage, instead of being the dearest, will be found to be the cheapest and one of the most economical methods of agricultural production. It is to be observed that all the factitious charges which have been specified—the results of bad legislation and maladministration by incompetent hands, from which, for the public protection, it ought to be removed—are usually passed over without any examination, and are presented as the natural and necessary results of sewage farming, that unavoidably render it more expensive than the prevalent ancient methods of agriculture. It is proper to note these great fallacies, and submit them for close examination, as was done by the Sanitary Congress for Berlin, which led to the adoption of the principle of the circulation of fresh sewage against that of stagnation and putridity; that is to say, of carrying a constant supply of pure spring water at high pressure into every house and into every flat of every house, and by self-cleansing house drains and apparatus, conveying immediately away, and before decomposition can commence, the fouled water into self-cleansing sewers, and by those self-cleansing sewers conveying it at once fresh and unwasted on to prepared land. This is what is being done in that city, though somewhat less perfectly, I believe, than might be, and very wastefully and slowly, as I consider, for the relief of the population. The principles of sanitation are now, I consider, so far established—as recently recited from my paper by Lord Basing, who presided at the last Sanitary Congress recently held in Bolton — that a capitalist might contract for the attainment of large results in the sanitary improvement of the lower classes of the population.

In the number of the *Fortnightly Review* for this month will be found an article by our member, Dr. B. W. Richardson, on the Thames and its condition, which deals specially with the remedies for it.

EDWIN CHADWICK.

Park-cottage, East Sheen,
Dec. 1, 1887.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

DECEMBER 14.—"Commercial Education." By SIR PHILIP MAGNUS. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

Papers for the meetings after Christmas:—

"Technical Instruction in Agriculture." By PROF. JOHN WRIGHTSON.

"Machine Tools for Boot and Shoe Manufacture." By JOHN W. URQUHART.

"Framework Knitting." By W. T. ROWLETT.

"Locks and Safes." By SAMUEL CHATWOOD.

"Telescopes for Stellar Photography." By SIR HOWARD GRUBB, F.R.S.

"The Measurement of Electrical Currents." By PROF. GEORGE FORBES, F.R.S.

"The Continuation of Elementary Education." By W. LANT CARPENTER, B.A., B.Sc.

"Type-writers and Type-writing." By JOHN HARRISON.

"Theatres and Fireproof Construction." By WALTER EMDEN.

"Methods of Taking the Ballot." Three papers by JOHN LEIGHTON, JAMES WITHERS, and JOHN IMRAY.

"The Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS.

"The Monumental Use of Bronze." By J STARKIE GARDNER.

"Style in Modern Architecture." By W. SIMPSON.

"The Public Health of India." By Mr. JUSTICE CUNNINGHAM, of the High Court of Judicature, Calcutta.

"Facts regarding the Religions of India." By SIR WILLIAM W. HUNTER, K.C.S.I., LL.D.

"Fruit Cultivation in India." By DR. BONAVIA.

"The Experience of Twenty Years in conducting Agricultural Inquiries in India." By W. R. ROBERTSON.

"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

CANTOR LECTURES.

The First Course will be on "The Elements of Architectural Design." By H. H. STATHAM. Four Lectures.

LECTURE III.—DECEMBER 12.—The statical conditions of the arched method of covering.—Distinction between the column and the buttress.—The "waggon" vault.—The dome and domed

architecture.—The development of the vault.—Transition from Romanesque to pointed architecture.—Constructive origin of the pointed arch.—Its development into the complete Gothic style.—Comparative analysis of Greek and Gothic styles.

LECTURE IV.—DECEMBER 19.—Architectural decoration.—Of two classes, moulded surfaces and carving.—The function of mouldings in architectural expression.—Their relation to material and climate.—Decorative carving.—Also influenced by material.—Its relation to nature and natural forms.—Applied decoration. — Architecture in cities. — Effective arrangement of sites.—Architecture and landscape.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON. Four Lectures.

January 30; February 6, 13, 20.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

JUVENILE LECTURES.

Two Juvenile Lectures on "The Application of Electricity to Lighting and Working," by WILLIAM HENRY PREECE, F.R.S., will be given on Wednesday evenings, January 4 and 11, 1888, at Seven o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. H. H. Statham, "The Elements of Architectural Design." (Lecture III.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. D. D. Daly, "Explorations in British North Borneo, 1883-87."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Henry Morley, "The Future University of London."

TUESDAY, DEC. 13...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Dr. Edw. Hopkinson's paper, "Electrical Tramways: the Bessbrook and Newry Tramway."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Edward Tregear, "The Maori and the Moa." 2. Rev. Benjamin Danks, "The Shell Money of New Britain."

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Mr. Walter Hazell, "Emigration."

WEDNESDAY, DEC. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Philip Magnus, "Commercial Education."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. 1. Mr. A. D. Michael, "A New Medium. 2. Mr. T. Rosseter, "Generative Organs of Ostracoda." 3. Mr. W. M. Maskell, "The Genus *Micrasterias*."

Pharmaceutical, 17, Bloomsbury-street, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7 p.m. 1. Mr. O. Imray, "Australian Patents and Privileges." 2. Mr. E. Carpmael, "A few obvious Amendments required in the Patents, &c., Act, 1883."

THURSDAY, DEC. 15...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. J. Pocock, "Myriopoda of Mergui Archipelago," 2. Rev. J. T. Gulick, "Divergent Evolution through Cumulative Segregation." 3. Prof. Bower, "Apogony and Apospery in Trichomanes." 4. Messrs. Johnston and Morgan, "Fertilisation of *Aranja sericifera*."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. W. Stokes, "An Apparatus for Comparison of Colour Tints." 2. Dr. Armstrong and Mr. W. P. Wynne, "The Sulphonation of Naphthalene." 3. Dr. Armstrong and Messrs. Amphlett, Williamson, and Wynne, "Isomeric Changes in the Naphthalene Series, Nos. 1, 2, 3, and 4." 4. Mr. C. H. Bothamley, "Note from the Chemical Laboratory of the Yorkshire College, Leeds; (1) The Reduction of Chlorates by the Copper-Zinc couple; (2) The Oxidation of Oxalic Acid by Potassium Bichromate; (3) A method of separating Supernatant Liquids." 5. Dr. E. J. Bell, "The Alloys of Copper and Antimony, and of Copper and Tin."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture II.)

Historical, 11, Chandos-street, W., 8½ p.m. Mr. H. E. Malden, "Historical Genealogy."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

FRIDAY, DEC. 16...Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Mr. John H. Parkin, "River-Gauging at the Vyrnwy Reservoir."

Philological, University College, W.C., 8 p.m. Mr. K. Dornbusch, "On Volapük."

Journal of the Society of Arts.

No. 1,830. Vol. XXXVI.

FRIDAY, DECEMBER 16, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving" will be delivered by Professor Hubert Herkomer, A.R.A., on Thursday evenings, February 2nd, 9th, and 16th, 1888. The lectures will be fully illustrated by examples of the processes.

Admission to these lectures will be under the same conditions as to Cantor Lectures.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 4th and 11th, 1888, by Mr. William Henry Preece, F.R.S., on "The Application of Electricity to Lighting and Working." The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

PRIZES FOR ART WORKMANSHIP.

The judges appointed by the Council of the Society of Arts have awarded the following prizes for objects submitted in the Art Workmanship Competition :—

Class I.—Painted Glass.

Second Prize (£15) to William Glasby, J. E. Penwarden, and A. Lawrenson, for careful execution of a painted panel, "Music," from a design by Henry Holliday. Flesh and general superintendence by William Glasby; drapery by John E. Penwarden; background by A. Lawrenson. (Exhibited by Messrs. Powell and Sons, Whitefriars, E.C.)

Class II.—Glass Blowing in the Venetian Style.

First Prize (£10) to T. Smith (workman), W. France, and W. Watkins (assistants), for soda lime vase with horns (copy); soda lime, blue tint, hollow twisted stem (adaptation); lead glass dish, enamel threads (copy); soda lime dented tumbler (adaptation); two tazzas, lead glass, pulled threading (original).

Second Prize (£5) to J. Hughes (workman), A. Johnston and H. Hart (assistants), for soda lime vase, hollow leg, frill on bowl (copy). (Exhibited by Messrs. Powell and Sons.)

Class IV.—Inlays in Wood.

Third Prize (£10) to F. Spalding, for fancy octagon table.

Class V.—Lacquer.

First Prize (£25) to Thomas W. Hay, for specimen of lacquer, with imitation of Limoges enamel, subject — "Bacchus and the Tyrrhenians."

Class VI. — Decorative Painting on Wood or Other Material.

First Prize (£25) to John Eyre, for painting on wood for piano front, subject—"Vocal and Instrumental Music."

Class VII.—Hand-tooled Bookbinding.

First Prize (£25) to T. J. Cobden-Sanderson, for two bound volumes, "The Germ," in green morocco, tooled all over with floral design in gold; and "Unto this Last," in red morocco, tooled all over in gold.

Second Prize (£15) to Fred. Mäullen for "Mireille," bound in orange Levant morocco, with pale blue morocco doublés and fly-leaves; outside ornamented with an original design in gold, inlaid with Venetian green morocco; doublés and fly-leaves finished with border and scroll work, in style of 16th century, and inlaid with red morocco. (Exhibited by Messrs. Zaehnsdorf.)

CLASS VIII.—REPOUSSÉ AND CHASED WORK IN ANY METAL.

First Prize (£25) to R. Holloway, for capital of column in hammered gilding metal.

First Prize (£25) to A. Hubert, for specimens in silver and other metals, of repoussé and cast chasing work.

Second Prize (£15) to W. Bullas, for repoussé curtain in brass, for drawing-room stove.

CANTOR LECTURES.

The third lecture of the course on "The Elements of Architectural Design" was delivered by Mr. H. H. STATHAM, on Monday evening, 12th inst. The lecturer dealt chiefly with the statical conditions of the arched method of covering, and traced the development of the vault, and the constructive origin of the pointed arch, concluding with a comparative analysis of the Greek and Gothic styles.

The first lecture will be printed in the next number of the *Journal.*

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 16th, 1887; SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Arthur, William Cresswell Ernest, Milligan-hall, near Taunton, Somerset.
Bernard, William Larkin, 7, Frederick-place, Clifton, Bristol.
Brocklesby, Harry Pearson, 9, Walbrook, E.C., and Clevelands, Stroud-green, N.
Eiloart, Frederick Edward, 40, Chancery-lane, W.C.
Fleuss, H. A., 19, Adelaide-road, Brockley, S.E.
Goldie, Sir George Taubman, K.C.M.G., Naval and Military Club, Piccadilly, W.
Hawkins, S. J., 18, Abingdon-street, S.W.
Hoster, Albert, 41, Cheapside, E.C.
Norman, George, M.R.C.S., 12, Brock-street, Bath, Somerset.
Rider, John H., Northern Telegraph Works, Halifax.
Samuel, Harry Sylvester, 80, Onslow-gardens, S.W.
Thompson, John, The Brewery-house, Albion Brewery, Mile-end, E.

The following candidates were balloted for and duly elected members of the Society:—

Adam, Alexander Learmouth, 40, Sir Michael-street, Greenock.
Albright, William Arthur, Mariemont, Birmingham.
Burne, Colonel Sir Owen Tudor, K.C.S.I., C.I.E., India-office, S.W., and 57, Sutherland-avenue, W.
Collard, Charles, The Brewery, Park-street, Southwark, S.E.
Glossop, William Dale, 1, Whitehall-gardens, S.W.
Hirst, Hugh Taylor, Ladcastle, Dobcross, Oldham, Lancashire.
Jowett, William, Lower-hall, Mellor, Stockport.
Krabbé, Charles Henry, Woodcote, 16, Cleve-road, West Hampstead, N.W., and Buenos Ayres, South America.
Tasker, John, Crookes-house, Sheffield.
Thompson, William Thomas, Frog Island Mills, Leicester.
Vaulin, Claude Theodore James, 23, Old Jewry, E.C.

The paper read was—

COMMERCIAL EDUCATION.

BY SIR PHILIP MAGNUS.

The question of how best to adapt our existing educational machinery to the requirements of commercial life, and of the additions, if any, that should be made to it, is now engaging the serious attention of merchants, manufacturers, teachers, and statesmen. The importance of the question is no longer doubted, and discussions of the subject are invited, with the view of eliciting the opinions of persons who, by their own knowledge and experience, are able to contribute to the solution of what must be regarded as a problem of national importance. To this end, an important conference was held under the auspices of the Chamber of Commerce, on the 23rd of November last, at which Sir John Lubbock, who is specially qualified to speak on this subject, delivered a very suggestive address, in which he pointed out many of the reasons which prevent our chil-

dren from obtaining in our secondary schools, at present organised, the preliminary training which might best prepare them for practical and commercial pursuits. He was followed by Dr. Percival, who sounded the keynote of industrial education when he said, "The true educational method for an industrial and commercial population like ours was to fix our attention far more than hitherto on the practical needs of our population, and so to endeavour to liberalise what were called the practical studies; and to dismiss, once for all, the old-world idea that studies which had a direct bearing on the needs of boys growing up in our schools somehow lost their humanising qualities."

The development of our trade and commerce may be said to depend on knowing not only how to produce at least cost what is most wanted, but also how to buy and sell with the utmost advantage. We may take it for granted that the full benefits that might result from the provision that has been made, during the last ten years, of facilities for technical instruction for all classes of producers will fail to be realised in the development of our trade and commerce, unless opportunities are afforded by which our youths may obtain that especial kind of training which is calculated to make them good business men.

Technical and Commercial Knowledge.

The economy of production is closely associated with that of distribution in the machinery of commerce, and the connection between the factory and the merchant's office is very intimate, and tends daily to become more so.

The progress of science is gradually converting the factory into a laboratory, in which raw materials are altered in substance or in form; and the success of productive industry depends on the skill and ingenuity with which this process of conversion is carried on. But mercantile success depends not only on the skill and ingenuity shown in the production of goods, but also on the care exercised in the purchase of the material employed, and on the special knowledge and ability displayed in the sale of the manufactured products. The highest technical knowledge might be employed in producing goods for which there was no demand, or, as has so frequently happened, for which the demand had ceased, and commerce would not thereby be advanced. Or goods might be produced excellent in quality, but unsaleable except at a loss at places already fully supplied. What is needed for the development of commerce is not only the faculty of *production* but also of *distribution*. A market is a necessary adjunct to a factory.

Now, the consideration of the kind of training which is best calculated to fit a person to buy and sell, and to engage in any of the operations, including banking operations, connected with the work of distributing and of bringing home to the consumer the products of industry, is the problem of commercial education.

Conditions of Modern Trade.

The altered conditions under which trade is now carried on have given to the solution of this problem a new and, until recently, a not sufficiently recognised importance. The application of science to the means of locomotion and of communication have changed many of the essential features of the geography of fifty years ago. Distant countries are now closely united by swift ocean steamers, by a net-work of rails, and by telegraphic wires. This development of scientific applications to the modes of transit and of communication has produced a revolution in our system of commerce, the effect of which we are only gradually coming to realise. It has intensified the severity of competition between different countries; it has diminished the value of the raw material in relation to that of the manufactured product; it has lessened the advantages due to natural resources; it has narrowed the margin of profit, rendering necessary the exercise of the greatest economy in the management of the mercantile department of a manufacturing business, and the utmost vigilance in securing the advantages of differences of exchanges, and in searching, wherever they may be found, for new and promising markets. When we hear, as we often do, successful manufacturers and merchants speak discouragingly of the necessity of commercial education, and tell us how, sent into the factory or office at an early age, they there acquired the practical experience to which they ascribe their fortune, we cannot but feel that such men overlook the fact that the conditions under which trade is now carried on are wholly different from what they were fifty years ago; and it is owing to this difference that a different and special kind of training has become indispensable. No one

can contemplate the changes which have taken place during the present half century without realising their levelling influence on the development of commerce, and the growing importance, as a factor of mercantile success, of that wider knowledge which enables those engaged in commerce to understand and to take advantage of, all favourable conditions in the conduct of business operations. The merchant's vision must extend beyond the limits of his own town or country. His observation must be widened, so that literally he may be able "to survey mankind from China to Peru." The range of his markets is continually extending, and his knowledge should be co-extensive with the area of his transactions. Education must adapt itself to these changed conditions. But education follows, and always at a great distance, social and intellectual changes; and the agitation for educational reform, which is now everywhere heard, is the expression of the conviction that education must be made to fulfil its proper function of training our young people for the work they have to do in the present altered conditions of industrial life.

Our Educational Deficiencies.

The success which, owing to our natural resources, attended our early efforts to apply steam-power to productive industry, led people to neglect the connection which ought to subsist between school-training and the business of life; whilst the absence of similar prosperity in other countries resulted in an earlier recognition of this important relationship. For this reason, technical and commercial schools were established abroad many years before the necessity for their creation was realised in this country; but the levelling influences of scientific progress, to which I have referred, have placed us at a comparative disadvantage with other countries, or rather, have lessened the advantages we formerly possessed on account of our natural resources, and have made it imperatively necessary that we should seek compensation in the endeavour to reap all the benefit we can from the improved and adequate education of our industrial classes. That our own school system does not afford the requisite training to enable our youths to compete on equal terms with the youths of other countries, especially of Germany, is shown by such evidence as may be found in the Reports of the Commissioners on "Technical Instruction," and on "the Depression of Trade and Industry," and in the reports of several of our Consuls in different parts of the world. To this evidence I do not propose to refer, seeing that it is accessible to every one, and has formed the subject of various newspaper articles, and of important addresses by Lord Hartington, Lord Rosebery, Professor Huxley, Sir John Lubbock, Sir Lyon Playfair, and other distinguished educational authorities.

Foreign School Systems.

The close connection, which, for many years, has been recognised by our continental neighbours to exist between school training and the business of life, and the success which, judging from the sources of information to which I have referred, seems to have attended the efforts of foreigners to push their trade in markets which were once our own, has naturally led us to inquire into foreign systems of education, not so much with a view of imitating as of comparing them with our own. A report, presented in September last to the Associated Chambers of Commerce, at their Exeter meeting, affords nearly all the information we require with regard to the facilities for instruction in commercial matters which are obtainable in foreign countries. A much fuller notice of foreign schools is given in a book by M. Léautey, entitled "Ecoles de Commerce," and in a similar but shorter book, written by MM. Jourdain et Dumont, the former being the director of the principal commercial school in Paris. In this month's "Contemporary Review," I have published a short notice of foreign schools of commerce, which embodies the substance of a paper read at the meeting of the British Association in September last, and renders unnecessary any detailed reference to these schools. The time at my disposal I propose, therefore, to devote to the consideration of the alterations in, and additions to, our own system of education, which are needed to place us on a level in the matter of commercial education with our foreign competitors in trade. It is only, however, by actual visits to foreign schools that we can realise how heavily our own children are handicapped in their struggle for their fair share of the commerce of the world, not only from the absence at home of special schools such as exist abroad, but also from the generally unsatisfactory and unorganised conditions of our intermediate and secondary education.

Some Features of Foreign Schools.—Languages.

In the curriculum of foreign schools of commerce, and of other schools in which youths are trained for industrial pursuits, the teaching of modern languages occupies a large amount of time. The methods of instruction are very different from those adopted in the majority of our own schools. Less attention is given to nice distinctions of grammar, and more to exercises in reading, writing, and composition. Although the teachers in most English schools are natives, foreign languages are too often taught by the same methods as those adopted in the teaching of classics. Now, although the teaching of French or German may be made to yield almost as much mental discipline as the teaching of Latin or Greek, the primary object of the instruction should be to enable the student to read, write, and speak, to carry on a conversation or correspondence in the language; and in the case of persons who are studying the language with a view to its use in commerce, the opportunity should be afforded to them of becoming familiar with the technical terms employed in ordinary business letters. In all foreign schools of commerce great attention is given to commercial correspondence, and in some of the schools, notably in the high schools of Paris, Antwerp, and Vienna, a system has been adopted known as the "Bureau Commercial," by which commercial transactions are carried on between pupils in different classes of the school as if they were in different countries, all details of the transaction being entered in the measures, weights, and coinage of the several countries. By this means an appearance of reality is given to the correspondence which, it is contended, cannot be otherwise equally well attained; and as the pupils in turn buy and sell different kinds of goods from different countries, they acquire a facility of writing business letters in foreign languages, and a knowledge of the charges imposed in different ports, and of the amount of freight on different classes of goods, and generally of all the details that have to be seen to in the purchase or sale of goods, and in their transport from one place to another. Opinions differ as to the value of this special training, but of the importance of familiarising students with foreign business correspondence before they enter business houses there can, I think, be very little doubt. Instruction of this kind is generally restricted to students of the higher classes, who have gained much of the knowledge on which their correspondence is founded by attendance at the courses of lectures on commercial geography, on the technology of merchandise, and on other matters connected with the economy of commerce.

Commercial Geography.

A knowledge of commercial geography may be considered, after modern languages, as the most important part of the equipment of a student for mercantile pursuits. Commercial geography implies even more than geography, as understood by Professor Geikie, who, regarding it as the study of the earth "as the dwelling place of man," gathers up into it all the sciences which are subservient to man's uses; for commercial geography may be considered as the study of the earth—first, in its relation to man generally, and secondly, in its relation to the commercial pursuits of man. Such a study involves a knowledge of the elements of physical, political, and ethnological science, and should dominate the greater part of the general science instruction which a student would receive in a commercial school. It involves, among other things, a knowledge of the natural products of different countries, and more especially of those which are of common use in commerce. To obtain an acquaintance with this part of the subject only, commercial museums are indispensable; and these are found in all the best Continental schools. It is impossible that a student, during his school course, or, indeed, during life, should obtain a complete knowledge of the various objects found in such a museum. But just as the geologist, *quâ* geologist, is satisfied to know the general characteristics of the minerals of which any rock is composed, and the organic remains which are found therein, without possessing the intimate knowledge of these matters which the chemist or biologist should possess, so the commercial student may be satisfied to know such of the properties of the substances he meets with, as are essential to his being able to distinguish them as commercial products, without necessarily possessing that deeper and more detailed knowledge which the specialist would seek to obtain. This study, which is known in the French schools as *Etude des Marchandises*, and in the German schools as *Waaren Kunde*, consists really of a series of advanced "object lessons," dealing with the principal materials of commerce, and illus-

trated in all cases by reference to actual specimens.

Professor Geikie rightly attaches much importance to this study in the teaching of ordinary geography. In his little book on "The Teaching of Geography," he says:—"If there are any special industries for which the school district is remarkable, these will of course receive due attention. In a village school, situated in a rural and agricultural district, for instance, the operations of farming will be fully considered; in a mining district all that can be intelligibly presented regarding mines and miners will be given with every available illustration. Among spinning-mills, the history of weaving will be readily appreciated, and as weaving and spinning are of such universal importance they should be fully explained with such samples of works and drawings of machinery as will give an adequate conception of the nature of these arts." If it is desirable that the teaching of geography should be so illustrated in the lessons given in ordinary schools, how much more important is it, that the commercial student should have access to a properly-equipped museum, and that he should learn at school something of the properties of the materials he is likely to meet with in his mercantile career. Such museums, which must be regarded as aids to the teaching of commercial geography, are necessarily of slow growth. Those in the high schools of Vienna and Antwerp are among the best equipped. The museum at the new school at Paris is full of specimens, and is carefully arranged, and the commercial departments of the district technical institutes of Italy contain museums which are full of objects illustrating all the principal branches of trade carried on in home and foreign markets.

Other Subjects.

The study of modern languages and of commercial geography, including the technology of merchandise and the elements of science underlying it, constitute the groundwork of a commercial education. These subjects should form the chief studies in all the grades of schools to which reference will later on be made. Of course there are other subjects included in every school curriculum, which a pupil would have to learn. The importance of an adequate knowledge of arithmetic and of mathematics cannot be over-stated; and under arithmetic should be included the principles of book-keeping which are common to any special system that may be adopted, and practice in the solution, and in the rapid solution, of mercantile problems. Good handwriting is a matter which should receive more attention than is generally given to it in ordinary schools. In the higher schools there are other subjects, such as mercantile law, the history of commerce, and the principles of political economy, which should be taught, and well taught, in order that the student may gain that wide and comprehensive knowledge of his business, which gives to professional studies a value as a means of intellectual discipline and culture.

Travelling Scholarships.

Another important feature of many foreign schools of commerce are the visits paid by the pupils to commercial firms and manufacturing works, and the travelling scholarships which are awarded to some of the students of the high schools and academies. In the case of the Antwerp academy, to which I have fully referred in my article in the *Contemporary Review*, the travelling scholarships, tenable by those students only who purpose to travel out of Europe, have been the means of establishing abroad important commercial houses, and, thereby, of augmenting the trade of the mother country. To award such scholarships to students who had not previously acquired a knowledge of foreign languages, and an acquaintance with the commercial geography of the country they intend to visit, would be of little use. "He that travelleth into a country before he hath some entrance into the language, goeth to school and not travel," Bacon tells us, and what is true of the language is almost equally true, so far as the commercial traveller is concerned, of the geography of the country. Of the value of such scholarships, when awarded to those whose minds are previously prepared to take advantage of the opportunities they offer of opening up new commercial relations, there can be, I think, very little doubt.

Needed Reforms.—Primary Instruction.

I now proceed to consider what modifications are needed in our system of education, to adapt it to the requirements of modern trade; but, in doing so, I do not propose to advocate the establishment of any separate schools of commerce, such as exist on the Continent. I believe all that is required can be obtained by

changes in the curriculum of some of our schools, and by the addition of new departments to other schools. Whether a youth is intended for commercial, manufacturing, medical, or legal pursuits, there are certain subjects of instruction which should equally enter into his school course; and it is, therefore, more advantageous and economical to establish schools with different departments than to erect separate schools adapted to the requirements of different branches of industry. The demands of commerce alone do not necessitate any special alterations in our system of elementary education. As has been pointed out by numerous witnesses who have been heard before the Royal Commission now sitting, our system of elementary education requires modification, but not specially with a view to the requirements of those who are to be engaged in commerce. The fact that nearly all children educated in our primary schools are likely to begin life by occupying humble positions in factories, shops, or mercantile houses, should be taken into consideration in framing a curriculum of studies for our elementary schools. It is the negleet of this consideration which has led to the demand for the introduction into these schools of teaching that is at once more useful and more practical.

Decimal Units of Measurement.

There is, however, one matter which affects our primary instruction, whilst it has an important bearing on our commerce generally, which ought not to be omitted from a discussion of the question of Commercial Education, viz., the advantage that would be derived from the general use of a decimal system of coins, weights, and measures. I think that the manifold advantages of such a change ought to be impressed upon our Government in connection with the present demand for improved facilities for commercial instruction. No very accurate estimate can be formed of the time occupied in our elementary schools in teaching children our unscientific method of estimating measures, weights, and values. It is, however, considerable. In this respect our children are at a great disadvantage compared with the children of other countries. Their progress in arithmetic is retarded, and the time spent in learning by heart their "tables" might be employed in the real work of education. I should say that the substitution of a system of decimal units for our own would result in a saving of time, in which a child might acquire a useful elementary knowledge of some foreign language. Perhaps more important than a decimal coinage is the adoption in commerce of the system of weights and measures employed in all scientific investigations, and now in general use throughout Europe. The assimilation of our own to foreign systems would be a great benefit to us. Not only would all commercial calculations in our home-trade be greatly simplified, but in our dealings with foreign countries the margin of profit, which for reasons already adduced is growing narrower and narrower, could be more exactly determined, and profitable transactions might be undertaken which, from want of precise knowledge, are often neglected as being of too doubtful advantage. Trade has become too exact a science to be profitably carried on by those who are not quite certain of the commercial value of their vulgar fractions.

Continuation Schools.

Whilst it is not desirable for the purposes of commerce that primary instruction should be specialised, it is most important that it should be continued until the child has obtained a firm grip of the subjects he is taught. To this end, leisurely and systematic study is indispensable, and this cannot be hoped for unless children are required to remain at school till the age of fourteen.

On leaving the elementary school, a great majority of the children go at once into the office, the factory, or shop. A few continue their education in some higher school. For both these classes a special training is desirable, if they are to be occupied in commercial pursuits. For those who leave school at an early age, "continuation classes" are indispensable, if the greater part of the nation's outlay on elementary education is not to be absolutely lost. I have known numerous instances in which lads of eighteen and twenty years of age have found themselves unable to avail themselves of the instruction given in the technical and science classes now established, in consequence of their having forgotten the little they had learnt in school. In my official capacity I have been asked whether oral examinations might not be substituted for written examinations, in consequence of the difficulty experienced by the candidates of expressing themselves in written language. Among the many excellent features of the German system of education, none is to be more commended than the regulation which compels children who leave

school at an early age to attend "continuation classes" till the age of sixteen. In this country, where no such compulsion exists, every encouragement should be afforded to apprentices in business houses to attend evening classes.

Evening Commercial Classes.

Classes in science and technology now exist in the principal towns of the kingdom. What is wanted are similar facilities for commercial education. A graduated course is needed, in which modern languages, arithmetic, geography, and commercial economics should form the principal subjects of instruction.

The documents to which I have referred show how well these courses of instruction are arranged abroad, and how common it is for merchants to encourage their clerks and apprentices to attend commercial classes, not only in the evening, but also in the afternoon. Let us turn for a moment to the programme of instruction at the Leipzig School of Commerce. This consists really of three schools, one of which is intended for young persons engaged in commercial houses. The course of instruction occupies three years, and each student is expected to devote ten hours a week to the lessons. The time is distributed as follows:—

	1st Year.	2nd Year.	3rd Year.
German	2	1	1
English	—	2	2
French	2	2	2
Arithmetic	3	2	2
Commercial science	—	1	1
Office practice	—	1	—
Geography	1	1	—
Writing	2	—	—
Book-keeping	—	—	2
	10	10	10

The instruction is given between 7 and 9 in the morning and evening, and between 2 and 4 in the afternoon. The pupils enter upon this course at 14 years of age, after having had 8 years of primary instruction. At Leipzig, besides these special commercial courses, there are evening courses, attendance at which is obligatory on all lads, be their occupation what it may, who have not continued their education at an intermediate or higher school; and in those courses, instruction is given in German, arithmetic, geometry, elementary science, geography, and history, the attendance of students at these classes in 1883 numbering 2,100. It is difficult to over-estimate the good done by taking the child at the age of 14, when he leaves the elementary school, and obliging him to attend evening classes during his apprenticeship.

Recent Progress.

Some useful attempts have been made in England to establish systematic instruction in commercial subjects.

At Nottingham, the sub-committee of the Chamber of Commerce, and of the University College, have drawn up a report, in which they suggest a systematic course of evening study, extending over three years, and occupying from three to seven hours a week. The course consists of three stages—an elementary, an intermediate, and an advanced stage; and the subjects of instruction comprise:—Book-keeping, English composition and correspondence, commercial arithmetic, commercial history, political economy, and mercantile law. They propose that certificates should be given to students who pass the obligatory parts of the examination, and they urge very strongly the importance of the recognition of these certificates by the merchants and bankers of the city.

University College, Liverpool, has established a two years' course of study for those who intend to enter commercial houses, and most recently King's College School has made arrangements for giving special instruction in a department of the school for those who are preparing for the Universities' Commercial Certificate.

But these and other efforts that might be mentioned are isolated endeavours, which do not affect the educational machinery of the country. As an indication that some of the highest educational authorities attach importance to the subject, such efforts are useful. But more is wanted.

Organisation of Evening Classes.

The organisation in all large towns of evening classes, with a well-arranged programme of studies extending over three years, is a necessary part of any system of commercial education. If our clerks are to hold their own against the competition of foreign clerks, opportunities must be afforded to them of making up, by evening instruction, for the deficiencies of their early education. In order that such classes may be established, commercial instruction must be placed on a

similar footing to the teaching of science and technology. So long as the system of payment on results continues in force, it must be extended to the teaching of commercial subjects. Until the sense of local responsibility has been further developed, and the advantages of local self-government are more fully appreciated, municipal authorities cannot be expected, even if permissive powers are conferred on them, to defray the entire cost of this additional instruction. The State must step in and help. Moreover, for some time, at least, the general guidance and control of some central body, which understands and pays due regard to local requirements, would be advantageous; and this guidance and control could best be secured by a system of examination and inspection, and by some modified system of payment by results. It is well known that, partly owing to the absence of such system, the Society of Arts failed to organise classes in technology, or to attract candidates, except in very small numbers, to its examinations; and the inability to give pecuniary assistance has undoubtedly been one of the causes of the paucity of candidates for its commercial examinations.

Changes in Secondary Instruction.

But, in order that the mass of the middle-classes may be properly trained for commercial, and, indeed, for industrial pursuits generally, our entire secondary education needs to be remodelled, and for the first time properly organised. It is the defects of our secondary education which are most affecting the trade interests of the country. And by secondary education I here mean all education between primary and university teaching. It includes the instruction given in our higher elementary, our "middle," and our endowed public schools. The technical and commercial education which the country needs cannot be provided until the teaching in our secondary schools has been reformed. We are constantly pointing to Germany as a country where higher education is more generally appreciated, where scientific knowledge is more widely diffused, where the cultivated classes are more numerous than they are in England. The explanation of the difference lies in the better system of secondary education in that country. Our higher elementary schools have yet to be created. Our middle schools are for the most part, parodies of our higher secondary schools, and these provide a training wholly unadapted to the existing requirements of the majority of the people.

It is not only—nor, indeed, principally—because Germany possesses numerous schools of commerce that she sends forth hosts of well-trained young men to occupy the best posts in foreign commercial houses, and to establish trading stations in all parts of the globe. It is mainly because her system of secondary education is adapted to the wants of the people Her sons are trained to observe and to think, and what they learn they can utilise in after life. This is not so with us. What we most want are good higher elementary or middle trade schools and a reorganisation of our intermediate and higher secondary schools.

Graded and Middle Schools.

The higher elementary schools should be similar in many respects to the excellent schools of France, some of which are fully described in the Report of the Commissioners on Technical Instruction. These schools should have a technical and a commercial side. Of the course of study to be pursued on the technical side, I gave an account in a paper read here in May, 1883. The commercial side might adopt a curriculum similar to that of the schools of commerce in Germany, and especially in Bavaria, to which full reference is made in the Report presented to the Chambers of Commerce; both in these and in our middle schools generally (the distinction between them being, that the former would be supported mainly by the rates and the latter out of ancient endowments), many of the subjects to be taught might be studied by the pupils of the technical as well as of the commercial side of the school. This is especially the case with English literature, the value of which, as a subject of school instruction, I am glad to see, has not been overlooked in the regulations of the Oxford and Cambridge Board for commercial certificates. Much of the time now spent in teaching disputed grammatical distinctions and antiquated forms of English words might, with advantage be devoted to the study of the masters of English, as the best preparation for the practice of English composition, as a means of developing the imagination and of stimulating an interest in good books. The claims of literature to occupy a prominent place in our education have been well expressed by Mr. John Morley, who tells us that it "furnishes the ideas which guide the conduct and mould the character, and it is upon conduct

and character that the future of this nation will depend."

The curriculum of these schools on the commercial side should embrace the following subjects:—English, including literature and history, foreign languages, commercial geography and the technology of merchandise, elementary science, arithmetic, including book-keeping, mathematics, writing, and drawing.

Many of our existing middle-class schools, if they would give up the profitless teaching of the rudiments of Latin grammar, might provide a commercial and technical training adapted to the children of the lower middle-classes, of small shopkeepers, of clerks, foremen and others, all of whom would be likely to be afterwards engaged in mercantile or manufacturing business. It would be necessary that the fees in these schools should be low, not exceeding £4; and, as is the case in the United Westminster School, and recently in the Cowper-street School, a large number of children, too poor to pay even these fees, should be admitted by exhibitions from the public elementary schools, and should thus be enabled to pursue their education on the technical or commercial side, according as their tastes or chances of subsequent employment might suggest. By such a system a boy's life's occupation would be, to some extent, determined for him during his school course, and his education would serve as a fitting preparation for his future work.

The curriculum I have indicated for the commercial side of these intermediate schools would, with some slight modifications, be equally serviceable for girls, who, it may be expected, will be every day more generally employed in public offices, and in certain departments of mercantile houses.

The Technical Instruction Bill.

If State aid is to be given towards the encouragement of commercial education in evening classes and in higher elementary schools, it must be provided for in the Technical Instruction Bill which will be introduced next Session into Parliament. The details of what that Bill should be I am not prepared now to discuss. Much of the benefit to be derived from it will depend upon the manner in which it is administered. As regards technical instruction, this question of administration is one of great importance. In its general features, I must own that the Bill introduced last Session was open to less objections than seem to have been urged against it. The great difficulty of getting a good Bill, *i.e.*, a Bill that shall effect all that is expected, consists in treating the question of technical education apart from that of the general education of the country. A new Department of Technology and Commerce might be created; but, except as regards science and art and elementary education, no corresponding departments would exist for other great divisions of education. Until, however, technical and commercial education can be considered as a part of the general education of the great mass of the people, as we hope before long it may be, we must look to the new Bill to provide some means of encouraging, by means of grants, instruction in commercial subjects both in evening classes and in higher elementary schools.

The Universities' School Certificate.

The new regulations for commercial certificates framed by the Oxford and Cambridge Schools Examination Board may possibly afford some encouragement to the more useful teaching of foreign languages and of commercial geography in some of the higher grade secondary schools; but the examination for these certificates, which is to be "adapted for candidates of about 17 years of age," each of whom is to be required to pay a fee of 25s. or of 35s. if examined away from his or her school, will, in no appreciable way, help forward the thousands of young people leaving school at about the age of 15, to whom the payment of 25s. would be a heavy burden, and who form the class from which the clerks of mercantile firms are recruited. At the conference held last month, Mr. Mundella well said, "It is not from our public schools, not from Eton, Harrow, or the Universities, that men were to be obtained who were to conduct the business of the country. The men who would have to do the drudgery of commercial life must come from another class;" and he went on to show that in Germany such men had been educated in the people's schools, in which the education was free, or in good secondary schools, in which the fees were very low. He told us that the average cost of higher education in Germany was £5 a year; and he might have added that in Bavaria the cost of the *Real* schools, which provide a sound middle class education, admirably adapted to the wants of those who are to be engaged in industrial life, is sixpence per week.

For our higher elementary and middle trade schools, which should be found in every commercial and manufacturing centre throughout the kingdom, the commercial certificates of the Universities will help very little. Nor is it the province of the Universities to afford this help. Help must come from the State in the form of free examinations and free certificates, and subsidies, by way of grants on results, or by such other mode of distribution as may be found practicable.

Higher Secondary Schools.

But besides the creation of State-aided elementary schools, and the formation of middle trade schools, with technical and commercial sides, other changes are needed for the satisfactory organisation of our secondary education. The course of study in many of our public endowed and other secondary schools, including our first grade schools, must be modified, with a view to the requirements of the several careers in which the pupils of these schools are likely to be engaged.

In reorganising our higher secondary education, our aim should be to make the instruction the best possible preparation for the subsequent work of the student. It is often said that whilst we live we learn; but, unfortunately, there is too frequently a sudden break between the training of the school and the training we obtain in the active business of life. This discontinuity in our education can only be avoided by teaching in school those subjects the knowledge of which a man or woman may utilise in after life. Now, it may be very desirable, as a preparation for certain careers, that children should commence at nine or ten years of age to write Latin and Greek verses, and that they should spend from ten to sixteen hours a week in the endeavour to read and write two ancient languages, which they will never require to write or speak, and the literature of which is well translated. But even if such an education is the best possible training—and I do not deny that it is so—for a small and limited number of children, it does not follow that all children, how diverse soever their tastes and future careers, should be passed through the same mill. Of course it is said that the classics are taught not for their use, but for the intellectual discipline which their study yields. But I think we may accept it as an axiom of the New Education, that modern literatures, science, and modern languages, if properly taught, may be made to yield an amount of intellectual exercise in no way inferior to that to be derived from the study of the classics. Without going over the arguments for and against the study of Latin and Greek, we may assume that the varied occupations in which men are now engaged, requiring for their successful pursuit highly-trained minds, demand greater diversity of preparatory studies than was necessary when the range of learned professions was much more limited. Engineering in all its branches, manufacturing industry, and commerce now claim to be regarded as callings or professions, requiring as broad and liberal an education as theology, medicine, or law.

What we need, therefore, are secondary schools, which offer a certain amount of choice of studies to the pupils. For those who are to be engaged in practical pursuits, the necessary linguistic training should be obtained through the medium of foreign languages, which in case of students preparing for commercial life should form the backbone of their studies. For those who show a taste for technical pursuits, or are likely to be employed in engineering or manufacturing industry, physical science should form the principal subject of instruction, whilst the classical languages might continue to occupy the major part of the time of those pupils who exhibit any literary aptitude. Our secondary schools would thus consist of three departments (*a*) classical, (*b*) science, and (*c*) modern languages. In each of these departments, the curriculum would embrace several other subjects in addition to the principal subject; but neither in the science, nor in the modern languages department, would the classics form a necessary part of the instruction. The omission of classics would leave time, which does not now exist where even Latin only is taught, for the practical study of physical and chemical science, without neglecting mathematics, literature, and other subjects, which are necessary parts of a liberal education.

If our secondary education were thus reorganised, the necessity for separate commercial schools, such as exist in France and Germany, would not be so keenly felt as it is at present. Our clerks and others who occupy the lower rungs of the commercial ladder would find a fitting training in the elementary school supplemented by evening instruction, or in the commercial side of the higher elementary or middle school, also supplemented by advanced lessons in evening classes. Others, whose means and social

position enable them to hope to obtain higher places, to become representatives abroad of mercantile houses, or to occupy the continually increasingly important post of foreign consul, would find in the general education, on lines such as I have indicated, of a good secondary school, the best preparatory training for a commercial career.

Higher Commercial Instruction.

What is needed to give completeness to the scheme I have sketched out are places of higher instruction corresponding, to some extent to the *Ecole des Hautes Etudes Commerciales* of Paris, to the *Handels Akademie* of Vienna, and to the new school of Genoa. These establishments are all intended to give the necessary professional training to young persons who have previously received only a general education. Having regard to existing circumstances, it would seem well that these higher commercial schools should form special departments of our metropolitan and provincial colleges. It would be desirable that a distinct course of instruction should be arranged for the students of this department, occupying at least two years, and embracing most of the subjects taught in the corresponding foreign schools. Students should be admitted to this course on passing an entrance examination, and a diploma should be awarded to those who satisfactorily complete it

To place this higher commercial training within reach of the poorer classes, leaving scholarships available at one of these schools should be established in connection with the higher elementary and middle schools to which I have referred. It is often said that scholarships do not benefit the poor, but only those who are in easier circumstances. This is very often the case when the scholarship is given on the results of a competitive examination open to all comers. But whilst scholarships of this kind are useful as raising the tone and character of the instruction of the institution in which they are tenable, it is very desirable, with the view of securing other students whose circumstances may not have been such as to place them in a position to compete on equal terms with better-off candidates, to attach leaving scholarships to particular schools, for the benefit of students who can pass the entrance examination of the institution in which they desire to pursue their education. If some of these scholarships were made available for children from the public elementary schools who had gone on to the middle schools, another gate would be found through which the children of the poor might enter the University.

The Need of Better Organisation.

Very few countries possess more efficient educational agencies than England, and nowhere, perhaps, are they worse organised. Our elementary education is systematically developed; so, too, are our evening classes in science, art, and technology. All else is in a chaotic condition. The remedy for this state of things has been pointed out by more than one authority on educational matters. It consists in the organisation of an Educational Department, presided over by a Minister of Education, whose jurisdiction should extend to all grades of education, from the primary school to the university. The institution of such an office need not in any way interfere with the valuable assistance which education must always receive from private efforts in the initiation and management of new movements. On the contrary, such movements would, to the extent only that would be necessary and no further, receive State aid. Abroad, it is common to find organisations for providing technical and commercial education, although locally controlled, receiving regular subventions from the State. Indeed, Government supervision may prove an advantage, if properly directed, in securing a high standard of efficiency in educational institutions, and in drawing public attention to the work they are doing. If such an office were created, the Minister would have cognizance of elementary, secondary, and university education, and many of the anomalies that now exist would disappear, and much uselessly expended energy would be avoided. It is to the reorganisation of our secondary education that we must largely look for that improvement in the efficiency and capabilities of out industrial classes, which we are too apt to believe can be brought about by the establishment of professional schools, whether technical or commercial. Professional instruction is now an indispensable complement of workshop or office practice, but its efficacy is altogether conditional on the fitness for the practical needs of the people of our elementary and secondary education, the reorganisation of which—and especially as regards commercial training, of the latter—should now engage the serious attention of all thoughtful statesmen.

Conclusion.

In this paper I have refrained from adducing evidence of the superiority of foreigners, and especially of Germans, as men of business; nor have I had time to take you into any of the German schools and show you how thoroughly German youths are taught those matters which they are able to utilise in after life. But Mr. Walter Besant, in a recent novel, has so happily described the German clerk, and has made him so fully explain the reason of his superiority to his Anglo-Saxon neighbour, that I cannot do better, to supply much that I have unavoidably omitted, than quote his words. Speaking of the varied knowledge which business operations now need, and which the German clerk has been at great pains to acquire, Dittmer Bock, the clerk introduced into the story, says:—

"Modern trade wants all this knowledge. There will soon be no more English merchants, because your young men will not learn the new conditions of trade. In every office there must be clerks who can write and speak foreign languages. Your young men will not learn them, and your schools cannot teach them. Then we come over—we who have learned them. For my part, I can write and read English, Swedish, Danish, French, Spanish, Italian, Dutch, and German. Do you think we shall be content to stay here as clerks? No—no. Do you think I have come here to sit down with forty pounds a year? We are cheap, we German clerks. You say so. Mein Gott! you will find us dear. We are learning your trade; we will find out all your customers and your correspondents; we learn your profits and we undersell you. We do not go away. We remain. And presently, instead of an English house, there is a German house in its place, because your young men are so stupid that they will not learn."

Let us hope that the publicity that has recently been given to our educational deficiencies, and the efforts we are now making to remedy them, will avert the consummation of the catastrophe which is here predicted!

DISCUSSION.

The Chairman said he had received a letter from Mr. Owen Roberts, Clerk to the Clothworkers' Company, enclosing the following resolution, which had been passed by the Company:—

"Clothworkers' Company,
"Court, Wednesday, Dec. 7th, 1887.

"Resolved:—That (having regard to the recommendations of the report on Commercial Education recently presented to the Associated Chambers of Commerce, and particularly to the recommendation in Appendix II. thereof, and in the full hope and expectation that other guilds, chambers of commerce, trade organisations, and societies may offer similar scholarships and prizes for competition, so as to give encouragement to the needed adaptation of our educational methods to the practical requirements of life, and to enable this country to maintain her commercial and industrial supremacy) a travelling scholarship and prizes, of the value of £100, for proficiency in the commercial languages (say Spanish, Portuguese, Italian, German, French, Russian, &c.) be placed at the disposal of the Society of Arts for the student who shall show the greatest proficiency in their examinations in commercial languages, while obtaining a certificate or diploma for proficiency in other specified subjects bearing on commercial and mercantile life required by a revived and revised curriculum and syllabus for commercial examinations, if the Society think fit to institute such."

Mr. J. G. Fitch said he had heard, with a good deal of sympathy, the suggestions which had been made for dealing with the great want, not only of a more complete system of organisation for secondary education, but especially of a commercial department in secondary schools. With regard to foreign languages, however, while he should be the last to depreciate the great value and importance of this subject, he would remark that the conditions were not quite the same here as they were in Germany and Switzerland. There, if a boy had any ambition to get on in the world, he knew the only way to do it was to learn some other language than his own, but an English boy had no such feeling, because he had the opportunity of going to the Colonies, India, or the United States, in any portion of which the English language was spoken. He did not say that was a reason for not teaching French, German, or Spanish; but it was just as well to bear in mind that the conditions affecting the English youth were not the same as those that obtained abroad. Then with regard to the great importance of a more rational system of arithmetical notation, of course no one knew better than an Inspector of Schools what an enormous waste of time there was in learning a confused and incongruous system of weights and measures, which now belonged to England almost alone of the civilised countries. But in urging the importance of the decimal system, he hoped the question of the decimalisation of money would be kept apart from that of weights and measures. The former would mean enormous difficulties—so great that he, as one who had watched the discussion upon that question for a great number of years, had no hesitation in saying that we were farther off decimal money than we were 20 years ago. There were great difficulties, either in reducing the English pound to a decimal form, getting rid altogether of the English penny, and substituting for it the half of a new coin to be called a

cent, or in altering the unit of value throughout the whole commercial world; and having regard to these difficulties, he believed it would be only waste of time to attempt to introduce a decimal coinage. But the decimalisation of weights and measures had a great deal more to be said for it, and he advised those who wished for reform in arithmetic would devote their attention mainly to that. The metrical system, which was now in use throughout the whole of Europe, would be an immense improvement. He was sure the paper would do much to educate public opinion with regard to this important subject.

Mr. JOSEPH BECK said he had listened with extreme interest to this paper, and rejoiced that a subject to which he had paid attention for years was now being taken up by persons whose opinions would carry far greater weight than those of mere outsiders. When speaking to teachers about these matters, they said they had no time for these subjects in the curriculum of the schools, and from their standpoint he thought this was true. In their opinion the children were sent to school for disciplinarian purposes, and not for making education an enjoyment, and in many of the elementary schools, instead of subjects being made attractive, they were the reverse. Another radical defect was the great development of memory at the expense of thought. Children were not taught to think at school as they ought to be, and he was quite sure that without more development of the thinking powers the improved education so many desired could not be introduced. The remarks made with regard to foreign schools were exceedingly apposite and instructive, but he believed in the power of the English youth to conquer difficulties when fairly attacked. Another practical difficulty was that in the middle-class schools the teachers were taken from the universities, and their endeavour was to train up all children in the curriculum in which they had been trained. That also would have to be got rid of. He lately saw a report from a school examiner, who said that where systems could be taught they were well taught, but where original thinking was required very little was accomplished. That was the main blot on our elementary and middle-class system. If they could but encourage original thought amongst young people, there would be no need for other inducements to lead them to embrace that kind of education which would be practically useful to them in after life.

Mr. B. L. COHEN said he was generally of opinion that those who had practical experience were best fitted to suggest the remedies which were needed. He believed in practical rather than in theoretical advisers, but this view had been considerably shaken in listening to this very instructive and suggestive paper. He knew that Sir Philip Magnus had no practical experience as an employer of labour, and probably did not know the inconveniences which those who were in search of clerks and subordinates experienced from the defects of business knowledge, but still there was not a single point he had omitted to mention or deal with. They often heard complaints made about the immigration of foreign poor, but to his mind there was much more danger from the immigration of well-to-do foreigners, who were displacing the backbone of our own country. He did not believe in protection of any kind, but certainly protection with regard to labour was impossible. The employer of labour would and must employ those who were likely to give him the best service at the smallest price, and unless and until they could manufacture and grow the living as well as the dead article on the same terms and to the same perfection as it could be got elsewhere, the best and cheapest article, whether in the shape of a clerk or a bale of silk, would be the one which was taken. For this reason the suggestions now made were of the greatest possible importance not only to the consumer but to the producer, by which he meant the parents of young men who had so much difficulty in finding employment. Mr. Fitch spoke of the different position of young men here and abroad, but he would point out that the intellectual versatility and powers of adaptation which these foreign clerks possessed was not in lieu of but in addition to the other matters which here were alone thought necessary. The English had an excellent business training and knowledge, had more stamina, more fibre, a better outward bearing, but they lacked the mental training which was so needful for the young men of the present day. They were taught the dead languages, which were very valuable accomplishments, and which no one who had the advantage of possessing would undervalue, but they were luxuries, and for the purpose of enabling young men to earn their living they wanted not dead but living languages. It was only when you could enable living persons not to study with a dictionary at their side, but to write, if possible, in shorthand, the words which were hurriedly dictated in any language, that you would put your own people on a level with the foreigner, in whom you had no such interest.

Mr. G. N. HOOPER said the Government was not idle in regard to this matter, for the Charity Commissioners were actively engaged in endeavouring to adapt some of the old endowments to the wants of the present day. They had issued a reformed scheme for some old charities which had existed in Westminster for two centuries, and within the last week or two her Majesty had approved the new scheme, which would now be put in force. When speaking to some of his friends as to the advantages of teaching workmen and clerks foreign languages, he had been met with jeers; but they had already heard how it was that in many parts of the Continent, young men who learned these things had an immense advantage over those who did not. When he was in Paris a few years ago, on a deputa-

tion from the National Federation of Employers, to ascertain something about the facilities for arbitration in commercial disputes, he was informed that though the study of foreign languages in France had been very much neglected for a long time, the people had awoke to its importance since the war, and the Jesuit fathers in Paris had, in many cases, undertaken the teaching of English and German free of expense, and that was going on to a considerable extent. Another matter which came a great deal under his notice during a recent visit to America, was the extensive use of shorthand and type-writing in all business houses for correspondence, by which much time was saved. The same was the case in Canada, where they had also adopted the American system of business colleges to which young men went for so many months, or a year, after leaving school, and which seemed to be much on the plan of those which had existed in Germany, France, and Austria, for many years. After a course at these colleges, the young men became useful and efficient clerks in a much less time when they went into active business life.

Dr. N. HEINEMANN said he had had the pleasure of hearing Sir Philip Magnus's lecture at Manchester, of reading his paper in the *Contemporary Review*, and of being present at the Conference held that day in Cannon-street, under the auspices of the London Chamber of Commerce; he had also read all that had been published on this subject, and when visiting his native country, Germany, he had made it a special study to become acquainted with the distinctive features of the commercial schools. Sir John Lubbock, in speaking on this subject last month, said he regretted very much that public schools like Eton, Rugby, and so on, should not teach commercial subjects and foreign languages; but his notion was that it would be much to be regretted if the higher schools of England should devote themselves to commercial pursuits. The culture and civilisation of a nation so great and powerful as England ought not to be monotonous, but diversified; there ought to be schools in which classical studies were cultivated, and on the other hand, there should be schools in which what in Germany was called *Real-Wissenschaften* should be studied; and others in which everything connected with commercial pursuits, in addition to general culture, should be taught. These three sides of the question ought always to be kept in view. He maintained that neither the universities nor the great public schools ought to aim at teaching commercial science, but other schools specially devoted to these subjects should be established; and they ought not to ask for the money of other people for this purpose, but do as they had in Paris and in Leipsic, where the merchants had established schools, and started a public company, and engaged professors who, in addition to general culture, were familiar with everything connected with commerce. Germany had been referred to with much admiration, but as a German he might be allowed to say that he thought they rather overrated the work of Germany, and underrated their own abilities, though this was a fault on the right side. Mr. Mundella, about a month ago, made a statement which he would take this opportunity of correcting. He said Germans came over like hungry wolves, and established themselves in the City, first as clerks, and afterwards as principals; and he went on to say that all these Germans came from the hungry and needy classes, but this was entirely a wrong notion. Every German who knew anything about his own country would say that these clerks sprang from every class in life; and here came in a principle which was of great interest for the student of political science. Whilst formerly if you asked a foreigner, or an Englishman who knew foreign countries well, to tell you the distinction between life in England and life on the Continent, the answer would have been that, here in England, everything which was great, powerful, and strong, and that did good for all classes, was done through private enterprise and self-help; whilst on the Continent, especially in Germany, almost everything was nursed either by the State or the community. Now, strange to say, this was entirely changed. Every one now was discouraging private enterprise, and looking to the State or the community to establish these schools. In Germany, whilst all the classical schools had been established by the town or State, all the commercial schools had been established by private individuals. He maintained that, while asking the question how to compete by education with foreigners, and especially with Germans, and while admiring the German system so much, it would be well to adopt the German system in this respect, and by this means they would soon see a rapid spread of such schools throughout the country.

Sir VINCENT KENNETT BARRINGTON said he had just returned from a long and interesting journey to all the capitals of Europe, where he had taken the opportunity of visiting the technical schools, and going into the question of commercial education, and he could fully bear out all that was said in the paper. Conversation with consuls and others proved to him that gradually, but surely, foreigners were catching us up in many markets. All were agreed that something must be done, but very few practical suggestions had been made. That afternoon he had heard Sir John Lubbock and Mr. Mundella speak at a meeting at the Chamber of Commerce, and he thought it must be a great gratification to that Society to find that the business men of London were now bestirring themselves on this question. Two practical suggestions were made. In the first place, to introduce the study of French, or some modern language, as a compulsory part of a university course; and the other was to extend the education in the Board schools, so as to include some central school, to which the more intelligent children might

be sent, to compete in some special branch of commerce or industry. There was considerable opposition on the part of the heads of schools, and others, to the interfering in any way with the university education, but he felt, with Sir John Lubbock, that the school curriculum was too much influenced by that of the universities. The whole course of education at those schools was designed with a view to boys winning scholsrships at the university, and the masters were university men. The same thing might be said about the examinations for the Civil Service, where more marks were given for Latin and Greek than for French or German, and this influenced the education of boys, whether going into the Civil Service or not. A head master of one great school almost told them that, as business men, they should mind their own business, and not interfere in education; but it was as business men looking after their own business that they were making these exertions. It was not the business of the schoolmaster, but of the parents, to say what education should be given, and the schoolmaster's duty was to carry it out. If this had been recognised long ago, we should not have had the absurd system of education for so many years in some of the principal schools. He was brought up at Eton, where the amount of mathematics he was allowed to learn entirely depended upon the amount of Latin and Greek he knew. There had been a great reform, under pressure, of several of the large schools. When he was at Eton there was one French master, but now there were seven modern masters; and in most grammar schools there was a modern side. One of the speakers that day said the pleasure of Greek literature was always a great consideration for those who had learned it. He had learnt Greek, but he must say that his recollection of it was in connection with pain. He had tried to make some statistics on this matter, and he found that more boys had to suffer pain in connection with the cultivation of the Greek language than with any other subject. With regard to decimal coinage, Mr. Samuel Montagu had taken up the question, and the Council of the London Chamber of Commerce had passed a resolution in favour of it, so that he thought it was only a question of time, when it would be accomplished. He had in his hand a chart showing the form or pedigree of education in Austria, in which was drawn out the different courses a child might follow, and how he might branch off from one to the other at the different stages, according to the occupation to which he intended to devote himself. The same thing occurred in Germany, and much the same thing in Belgium, and in fact in all countries until he came to England, where, excepting in the Board schools, there was utter confusion everywhere.

Mr. JOHN BARKER said he completely differed from Mr. Fitch in two points he had mentioned. He had had the opportunity of learning seven or eight languages, having been born in the Levant, and being connected by descent with the old Levant Company. In old days not only were languages taught, but technical knowledge and commerce also, and it was by that means that England obtained such immense power in the East, founded the East India Company, and became the greatest commercial and manufacturing country in the world. At that time they used to send travellers with a perfect knowledge not only of the languages but of the countries where they wanted to open commerce, and with a technical knowledge of the goods they wished to introduce, and whose business it was to study the wants of the people and the patterns required. For a long time our manufactures were pre-eminent, especially in soft goods, but competition unfortunately led to reduction of quality, and we lost our status by trying to undersell our competitors. His experience was that every boy who wished to enter commercial life should acquire a knowledge of foreign languages. But there was one great defect in the teaching of Latin and Greek in England, inasmuch as they were taught to be pronounced as if they were English. He was taught Latin in such a way that it helped him to learn French, Spanish, Italian, and Portuguese, and Greek so that he was able to read and write modern Greek. He was also of opinion that a decimal coinage would be a great advantage. He always made his calculations, even of English money and weights and measures, in decimals, and he could do it in one-fourth the ordinary time.

Mr. WALTER BOUTALL said he had been connected for some ten years with the City of London College, and had been much struck with the want of organisation both in the subjects and method of teaching. Pending the introduction of State superintendence, the kind of assistance most needed was with regard to the examinations, and in directing and controlling the education given. In reference to commercial geography, they had frequent applications to study it, but could never get a satisfactory class for want of an efficient teacher. Most teachers would just give the dry bones of topographical knowledge, and nothing further. If the Royal Geographical Society would arrange for something like an extended course in this subject, many of the differences would disappear.

Mr. D. H. SHUTTLEWORTH-BROWN said it was not necessary to compliment Sir Philip Magnus on the paper, which was as complete as it could be as a matter of theory, but an ounce of practice was worth a ton of theory. He remembered in 1868 a young man coming to London with recommendations from and to eleven members of Parliament, and failing to find any employment. He then tried his own resources, and went from office to office until he had covered 300 and odd, at every one of which he offered his services for nothing. At last his offer was accepted, on account of his bold hand-

writing, and he gave his services for 12 months. Towards the end of the term his employer asked what remuneration he would expect if he remained, when he said he did not expect any more than he was worth. His employer replied:—"The question is not what you are worth, but what we can get the work done for. The gentleman who occupied your place before paid us a premium of 300 guineas, but your exceptional abilities induced us to engage you without paying a premium." The result was that the young man left, and finding nothing else to do, tried what he could do at teaching. In answer to an application, he called on the principal of a large school, who asked him how he should teach geography. Having gained twelve years' commercial experience, he replied that instead of teaching a list of the rivers in England on the various coasts, he should take "Bradshaw" and show to which towns the railways went; then take the *Public Ledger* and look for the list of ships, see where they went, teach the characteristics of the different ports, and discourse on the cargoes which the ships carried, and so on. All this seemed so extremely irrational to the principal that the interview soon came to an end. In considering the question of a commercial education, it was necessary to bear in mind the proportion between the importance of the buying and selling faculty and the productive faculty. Buying and selling was only for the sake of making a profit on that which was produced; and if we were only a nation of buyers and sellers we could not enrich the country by that means. The Germans who came over here to sell did not produce. They came over as clerks, they learned about the things manufactured in this country, they had friends at home who were manufacturers, and ended by leaving their situations as clerks, and being appointed agents for German manufacturers. He could not disagree with a single point in the paper, but at the same time he would point out that technical and productive education was more important than commercial.

Mr. SCHLOSS hoped that one point in commercial education would not be forgotten, and that the time was not far distant when every English boy would learn a trade. He was at a meeting at a technical school in Finsbury, when a speaker said there were plenty of men in Clerkenwell who could make first-class watches and clocks, but there was no demand for them, as people would put up with things the works of which would disgrace a warming-pan. In the same way lots of German knives and things were sold here because people did not know the difference between them and good Sheffield cutlery. He hoped the time would come when an Eton or Harrow boy would be able to distinguish, not only between good form and bad form in the cricket or football field, or on the river, but would know the difference between a good and bad knife, or piece of furniture. When that time came there would be less foreign rubbish and more first-class goods made in England.

The CHAIRMAN then proposed a vote of thanks to Sir Philip Magnus, which was carried unanimously.

Sir PHILIP MAGNUS, in reply, said Mr. Barker had so fully answered Mr. Fitch that he did not tnink it necessary to say much with regard to the two points to which he directed attention. He did not attach much weight to his suggestion that the importance of English boys learning foreign languages was less than in the case of a foreign boy, on account of the opportunity of being employed in the Colonies, because a great deal of the trade done in the Colonies would be with countries either in Europe or South America, in which foreign languages were spoken, and if he were unable to correspond in French, German, and Italian, he would be soon outstripped in the race. He agreed with Mr. Fitch that decimal weights and measures were more important than decimal coinage, and transactions would be carried on with much greater ease and profit if the decimal system which prevailed on the Continent were adopted here. Dr. Heinemann had advocated separate schools for providing different kinds of education; but, for the reasons he had given, he thought it would be more advantageous that there should be separate departments in the existing schools, than introduce new ones altogether. It was quite true that the commercial schools in Germany and France had been for the most part established by private companies, and were maintained by the fees of the scholars, and by a small subvention from the State or municipality. He took great pains, when on the Continent nine months ago, to ascertain whether the commercial schools were on the increase or decrease, and it appeared that there was a general feeling that the special commercial schools of Germany were not likely to increase in face of the splendid education, almost equally well adapted to commercial pursuits, now given in the *real* schools. For that reason, he advocated first of all that we should have higher elementary schools with a technical and commercial side, which seemed to fall in very well with the suggestions made that afternoon at the Conference to which Sir Vincent Kennett Barrington had alluded. It was a matter of great importance that they should have higher central schools, with a technical or commercial side; and also that the middle-class schools should be remodelled in the same direction, and made three-sided, so as to adapt them to the different careers of the boys. These were three practical suggestions, and in addition to these there should be evening classes devoted to commercial subjects for those who were already engaged in business. Mr. Boutall had referred to the great want of teachers of commercial geography, and it was no doubt a lamentable fact that in the whole of this country there had not been for many years a single candidate who had come up for the Society of Arts' examination in commercial geography. This was not entirely the fault of the children, nor even of the

teachers, as they had not yet been trained. The Imperial Institute was intended to promote various important objects, but he did hope that one to which it would give effect would be to afford facilities for training up teachers in commercial geography. The question opened up by Mr. Schloss was hardly within the scope of the paper, and it was much too late to enter upon it then.

Obituary.

B. Richardson.—Mr. Benjamin Richardson, a member of the Society of Arts since 1847, died at his residence at Wordsley-hall, near Stourbridge, on the 30th ult. He was born on March 9th, 1802, and at an early age became connected with the glass trade. After being manager of glass works at Dudley, he undertook the management of those at Wordsley, which afterwards came into the hands of Mr. Thomas Webb and Mr. Richardson and his brother. Subsequently Mr. Webb retired, and another brother of Mr. Richardson took his place. In 1847, a gold medal was presented by the Society to Messrs. Richardson and Co. "for their specimen of enamelled colours on glass," and in the following year a silver medal to Messrs. H., B. and J. Richardson "for the beauty and purity of their glass, and for the merit of their works in engraved glass."

General Notes.

Bologna Emilian Provinces Exhibition.—The International Exhibition of Music about to be held next year, in commemoration of the eighth centenary of the Bologna University, will be open from May 1st to October 31st. In addition to the International Exhibition of Music there will be a National Exhibition of Contemporary and Historical Fine Arts, and a Provincial Exhibition of Manufactures and Agriculture.

Munich International Art Exhibition.—This Exhibition will be held in the Royal Crystal Palace at Munich. It will be opened on the 1st June, 1888, and will continue open until the end of October. Works of art of all countries in the departments of painting, sculpture, architecture, drawing, and reproduction, are admitted. Works of art industry, if they are entitled by artistic invention and execution to be considered as works of art, will also be admitted, but only on the special invitation of the Central Committee, or by the Collective Commissioners. The Central Committee defray the expenses of transport of all works of art approved by a jury of admission. All applications must be received by the Central Committee (Luitpoldstrasse, Nr. 3, München) by the 15th March next, but no work of art must arrive at Munich before the 1st April.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. H. H. Statham, "The Elements of Architectural Design." (Lecture IV.)
Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Various papers on "Inventions suitable for the Household."
British Architects, 9, Conduit-street, W., 8 p.m.
Actuaries, The Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Henry Morley, "The Future University of London." (Lecture II.)

Tuesday, Dec. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion on Dr. Edw. Hopkinson's paper, "Electrical Tramways: The Bessbrook and Newry Tramway." 2. Paper by the late Mr. Hamilton Goodall, "The Use and Testing of Open-hearth Steel for Boiler-making."
Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Sir Juland Danvers, "The Defects of English Railway Statistics."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "Observations on Hooker's Sea-lion (*Otaria hookeri*). 2. Mr. G. A. Boulenger, "Description of a new Genus of Lizards of the family Teiidæ." 3. Rev. H. S. Gorham, "Revision of the Japanese Species of *Endomychiolæ*."

Wednesday, Dec. 21...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. H. S. Eaton, "Mean Temperature of the Air at Greenwich, from September, 1811, to June, 1856." 2. Rev. T. A. Preston, "Report on the Phenological Observations for 1887." 3. Prof. John Milne, "Earth Tremors and the Wind." 4. Prof. H. Allen Hazen, "Pressure and Temperature in Cyclones and Anticyclones."
Geological, Burlington-house, W., 8 p.m. 1. Prof. Joseph Prestwich, "The Correlation of some of the Eocene Strata in the Tertiary Basins of England, Belgium, and the North of France." 2. Prof. J. F. Blake, "The Cambrian and Associated Rocks in North-West Caernarvonshire." 3. Mr. R. D. Oldham, "The Law that Governs the Action of Flowing Streams."
Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.
Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Mr. A. T. Walmisley, "The Roof of the National Agricultural Hall, Kensington."

Thursday, Dec. 22...Egypt Exploration Fund (at the House of the Society of Arts), 4 p.m.
Royal, Burlington-house, W., 4½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture III.)

Friday, Dec. 23...Egypt Exploration Fund (at the House of the Society of Arts). 4 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.

Correction.—Page 93, col. 1. Mr. Hannay's name should be J. B. Hannay, and not J. W. as there printed.

Journal of the Society of Arts.

No. 1,831. Vol. XXXVI.

FRIDAY, DECEMBER 23, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

All the tickets for these lectures having now been disposed of, the issue is stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

CANTOR LECTURES.

The fourth and concluding lecture of the course on the "Elements of Architectural Design" was delivered by Mr. H H. Statham, on Monday evening, 10th inst. The lecturer dealt more especially with architectural decoration, which he divided into the two classes of functional and applied. In conclusion, he referred to with the question of the effective arrangement of sites.

On the motion of the Chairman (Mr. Francis Cobb), a cordial vote of thanks to the lecturer for his interesting course of lectures was passed.

With this number of the *Journal* is issued a supplement of three pages, containing the figures illustrating Mr. Statham's first lecture, printed on page 116.

PRIZES FOR ART WORKMANSHIP.

The following prizes have been awarded for objects submitted in the Art Workmanship Competition :—

Class I.—Painted Glass.

Second Prize (£15) to William Glasby, J. E. Penwarden, and A. Lawrenson, for careful execution of a painted panel, exhibited by Messrs. Powell and Sons, Whitefriars, E.C., "Music," from a design by Henry Holliday. Flesh and general superintendence by William Glasby; drapery by John E. Penwarden; background by A. Lawrenson. *Awarded under the Stock Trust.*

Class II.—Glass Blowing in the Venetian Style.

First Prize (£10) to T. Smith (workman), W. France, and W. Watkins (assistants), for soda lime vase with horns (copy); soda lime, blue tint, hollow twisted stem (adaptation); lead glass dish, enamel threads (copy); soda lime dented tumbler (adaptation); two tazzas, lead glass, pulled threading (original).

Second Prize (£5) to J. Hughes (workman), A. Johnston and H. Hart (assistants), for soda lime vase, hollow leg, frill on bowl (copy). (Exhibited by Messrs. Powell and Sons.)

Class IV.—Inlays in Wood.

Third Prize (£10) to F. Spalding, for fancy octagon table.

Class V.—Lacquer.

First Prize (£25) to Thomas W. Hay, for specimen of lacquer, with imitation of Limoges enamel, subject — "Bacchus and the Tyrrhenians." *Awarded under the Davis Trust.*

Class VI. — Decorative Painting on Wood or Other Material.

First Prize (£25) to John Eyre, for painting on wood for piano front, subject—"Vocal and Instrumental Music." *Awarded under the Fothergill Trust.*

Class VII.—Hand-tooled Bookbinding.

First Prize (£25) to T. J. Cobden-Sanderson, for two bound volumes, "The Germ," in green morocco, tooled all over with floral design in gold; and "Unto this Last," in red morocco, tooled all over in gold.

Second Prize (£15) to Fred. Mäullen for "Mireille" (exhibited by Messrs. Zaehnsdorf.), bound in orange Levant morocco, with pale blue morocco doublés and fly-leaves; outside ornamented with an original design in gold, inlaid with Venetian green morocco; doublés and fly-leaves finished with border and scroll work, in style of 16th century, and inlaid with red morocco.

Class VIII.—Repoussé and Chased Work in any Metal.

First Prize (£25) to R. Holloway, for capital of column in hammered gilding metal.

First Prize (£25) to A. Hubert, for specimens of silver and other metals, of repoussé and cast chasing work.

Second Prize (£15) to W. Bullas, for repoussé curtain in brass, for drawing-room stove.

The three prizes were awarded under the Davis Trust.

The Exhibition of objects sent in for competition will be closed to-day.

The objects which have obtained the prizes will be exhibited (by permission of the Lords of the Committee of Council on Education) at the South Kensington Museum.

Proceedings of the Society.

CANTOR LECTURES.

ELEMENTS OF ARCHITECTURAL DESIGN.

By H. H. Statham.

Lecture I.—Delivered November 28, 1887.

Judging from the nature of the correspondence on architecture and the duty of architects which is frequently seen in the columns of the daily papers, the *Times* especially, it would seem that the popular notion of architecture now is that it is a study mainly of things connected with sanitary engineering—of the best forms of drain-pipes and intercepting traps. This is indeed a very important part of sound building, and it is one that has been very much neglected, and has been, in fact, in a comparatively primitive state until very recent times; and therefore it is not surprising that there should be a reaction in regard to it, and that newspapers which follow every movement of public opinion, and try to keep pace with it, should speak as if the drain-pipe were the true foundation of architecture. I have a great respect for the drain-pipe, and wish to see it as well laid and "intercepted" as possible; but I think, for all that, that there is something in architecture higher than sanitary engineering. I wish to consider it in these lectures as what I think it essentially is—what it has evidently been in the eyes of all those of past days who have produced what we now regard as great architectural monuments, namely, as an intellectual art, the object of which is to so treat the buildings which we are obliged to raise for shelter and convenience as to render them objects of interest and beauty, and not mere utilitarian floors, walls, and roofs to shelter a race who care nothing for beauty, and who only want to have their physical comfort provided for.

Architecture, then, from the point of view from which I am asking you to regard it—and the only point of view in which it is worth the serious regard of thoughtful people—is the art of erecting expressive and beautiful buildings. I say expressive *and* beautiful, and I put expressive first, because it is the characteristic which we can at least realise even when we cannot realise what can fairly be called beauty, and it is the characteristic which comes first in the order of things. A building may be expressive and thereby have interest, without rising into beauty; but it can never be, architecturally speaking, beautiful unless it has expression. And what do we mean by expression in a building? That brings us to the very pith of the matter.

We know pretty well what we mean when we say that a painted or sculptured figure is expressive. We mean that, while correctly representing the structure of the human figure, it also conveys to our minds a distinct idea of a special emotion or sentiment, such as human beings are capable of feeling and expressing by looks and actions. Expression in this sense a building cannot be said to have. It is incapable of emotion, and it has no mobility of surface or feature. Yet I think we shall see that it is capable of expression in more senses than one. It may, in the first place, express or reflect the emotion of those who designed it, or it may express the facts of its own internal structure and arrangement. The former, however, can only, I think, be said to be realised in the case of architecture of the highest class, and when taken collectively as a typical style. For instance, we can all pretty well agree that the mediæval cathedral expresses an emotion of aspiration on the part of its builders. The age that built the cathedrals longed to soar in some way, and this was the way then open to it, and it sent up its soul in spreading vaults, and in pinnacles and spires. So also we can never look at Greek architecture without seeing in it the reflection of a nature refined, precise, and critical; loving grace and finish, but content to live with the graces and the muses without any aspirations that spurned this earth. We can hardly go further than this in attributing

emotional expression to architecture. But in a more restricted sense of the word expression, a building may express very definitely its main constructive facts, its plan and arrangement, to a certain extent even its purpose, so far at least that we may be able to identify the class of structure to which it belongs. It not only may, but it ought to do this, unless the architecture is to be a mere ornamental screen for concealing the prosaic facts of the structure. There is a good deal of architecture in the world which is in fact of this kind—an ornamental screen unconnected with the constructional arrangement of the building; nor is such architecture to be entirely scouted; it may be a very charming piece of scenery in itself, and you may even make a very good theoretical defence for it, from a certain point of view; but on the whole, architecture on that principle becomes uninteresting; you very soon tire of it; it is a mask rather than a countenance, and tends to the production of a dull uniformity of conventional design.

For we must remember that architecture, although a form of artistic expression, is not, like painting and sculpture, unfettered by practical considerations; it is an art inextricably bound up with structural conditions and practical requirements. A building is erected first for convenience and shelter; secondly only for appearance, except in the case of such works as monuments, triumphal arches, &c., which represent architectural effect pure and simple, uncontrolled by practical requirements. With such exceptions, therefore, a building ought to express in its external design its internal planning and arrangement; in other words, the architectural design should arise out of the plan and disposition of the interior, or be carried on concurrently with it, not designed as a separate problem. Then a design is dependent on structural conditions also, and if these are not observed the building does not stand, and hence it is obvious that the architectural design must express these structural conditions; it must not appear to stand, or be constructed in a way in which it could not stand (like the modern shops which are supposed to stand on sheets of plate-glass), and its whole exterior appearance ought to be in accordance with, and convey the idea of, the manner and principle on which it is constructed. The most important portions of the interior must be shown as such externally by the greater elaboration and emphasis of their architectural treatment. If the general arrangement of the plan is symmetrical, on either side of a centre (which, however, it cannot often be except in the largest type of monumental or public buildings), the architectural treatment must be symmetrical; if the building is necessarily arranged, in accordance with the requirements of the plan unsymmetrically, the architectural treatment must follow suit, and the same principle must be carried out through all the details.

Now this dependence of architectural design upon plan and construction is one of the conditions which is often overlooked by amateurs in forming a judgment upon architectural design; and the overlooking of this is one reason of the uncertainty of opinion about architecture as compared with such arts as sculpture and painting. Few people know or care much about the structure and planning of buildings except those whose business it is to care about this; and consequently they do not realise what it is which they should look for in the architectural design. They like it or do not like it, and they regard this as what is called a mere question of taste, which, according to the proverb, is not to be disputed about. In fact, however, the good or bad taste of an architectural design, say, if you like, its correctness or incorrectness, is to a considerable extent a matter of logical reasoning, of which you must accurately know the premises before you can form a just conclusion. But there is another reason for this prevalent uncertainty and vagueness of opinion, arising out of the very nature of architectural art itself, as compared with the imitative arts. A painting of a figure on a landscape is primarily a direct imitation of the physical facts of nature. I do not for a moment say it is only that, for there is far more involved in painting than the imitation of nature; but the immediate reference to nature does give a standard of comparison which to a certain extent every eye can appreciate. But architecture is not an art which imitates natural forms at all, except as minor decorations, and it then does so, or should do so, only in a conventionalised manner, for reasons which we shall consider later on. Architecture is, like music, a metaphysical art; it deals with the abstract qualities of proportion, balance of form, and direction of line, but without any imitation of the concrete facts of nature. The comparison between architecture and music is an exercise of the fancy which may indeed be pushed too far, but there is really a definite

similarity between them which it is useful to notice. For instance, the regular rhythm, or succession of accentuated points in equal times, which plays so important a part in musical form, is discernible in architecture as a rhythm in space. We may treat a cottage type of design, no doubt, with a playful irregularity, especially if this follows and is suggested by an irregularity of plan; but in architecture on a grand scale, whether it be in a Greek colonnade or a Gothic arcade, we cannot tolerate irregularity of spacing except where some constructive necessity affords an obvious and higher reason for it. Then, again, we find the unwritten law running throughout all architecture that a progress of line in one direction requires to be stopped in a marked and distinct manner when it has run its course, and we find a similarly felt necessity in regard to musical form. The repetition so common at the close of a piece of music of the same chord several times in succession, is exactly analogous to the repetition of cross lines at the necking of a Doric column to stop the vertical lines of the fluting, or to the strongly marked horizontal lines of a cornice which form the termination of the height or upward progress of an architectural design. The analogy is here very close. A less close analogy may also be felt between an architectural and a musical composition regarded as a whole. A fugue of Bach's is really a built-up structure of tones (as Browning has so finely put it in his poem, "Abt Vögler"), in accordance with certain ideas of relation and proportion, just as a temple or a cathedral is a built-up structure of lines and spaces in accordance with ideas of relation and proportion; both appeal to the same sense of proportion and construction in the brain, the one through the ear, the other through the eye. Then, in regard to architecture again, we have further limiting conditions arising not only out of the principle of construction employed, but out of the physical properties of the very material we employ. A treatment that is suitable and expressive for a stone construction is quite unsuitable for a timber construction; details which are effective and permanent in marble are ineffective and perishable in stone, and so on; and the outcome of all this is that all architectural design has to be judged not by any easy and ready reference to exterior physical nature, with which it has nothing to do, but by a process of logical reasoning as to the relation of the design to the practical conditions, first, which are its basis, and as to the relation of the parts to each other. Of course beyond all this there is in architecture, as in music, something which defies analysis, which appeals to our sense of delight we know not how or why, and probably we do not want to know; the charm might be dissolved if we did. But up to this point architectural design and expression are based on reasoning from certain premises; the design is good or bad as it recognises or ignores the logic of the case, and the criticism of it must rest on a similar basis. It is a matter of thought in both cases, and without thought it can neither be designed nor appreciated to any purpose, and this is the leading idea which I wish to urge and to illustrate in these lectures.

You may say, may not a design satisfy all these logical conditions, and yet be cold and uninteresting, and give one no pleasure? Certainly it may; indeed, we referred just now to that last element of beauty which is beyond analysis; but, if we cannot analyse the result, I rather think we can express what it is which the designer must evince, beyond clear reasoning, to give the highest interest to his architecture. He must have taken pleasure and interest in it himself. That seems a little thing to say, but much lies in it. As Matthew Arnold has said of poetry:—

> "What poets feel not, when they make
> A pleasure in creating,
> The world, in its turn, will not take
> Pleasure in contemplating."

The truth runs through all art. There are, alas, so many people who do not seem to have the faculty of taking pleasure; and there is so much architecture about our streets which it is impossible to suppose anyone "took pleasure in creating." When a feature is put into a design not because the designer liked it but because it is the usual thing and it saves trouble, it always proclaims that melancholy truth. But where something is designed because the designer liked doing it, and was trying to please his own fancy instead of copying what a hundred other men have done before, it will go hard but he will give some pleasure to the spectator. It is from this blessed faculty that a design becomes inspired with what is best described as "character." It is not the same thing as style. I have something to say in my next lecture as to what I think *style* means; but it is certain that a building may have *style* and yet want *character*, and it may have a good deal of *character* and yet be faulty or contradictory

in *style*. We cannot define "character," but when we feel that it is present we may rely upon it that it is because the designer took interest and pleasure in his work; was not doing it merely scholastically—in short, he put something of his own character into it; which means that he had some to put.

Now, coming back to the axiom before mentioned, that architectural design should express and emphasise the practical requirements and physical conditions of the building, let us look a little more in detail into the manner in which this may be done. We will take, to begin with, the very simplest structure we can possibly build—a plain wall (Fig. 1).* Here there is no expression at all; only stones piled one on another, with sufficient care in coursing and jointing to give stability to the structure. It is better for the wall—constructively, however, that it should have a wider base, to give it more solidity of foundation, and that the coping should project beyond the face of the wall, in order to throw the rain off, and these two requirements may be treated so as to give architectural expression to our work (Fig. 2). It now consists of three distinct portions—a plinth, or base, a superficies of wall, and a coping. We will mark the thickening at the base by a moulding, which will give a few horizontal lines (at B), and the coping in the same way. The moulding of the coping must also be so designed as to have a hollow throating, which will act as a drip, to keep the rain from running round the under-side of the coping and down the wall. We may then break up the superficies by inserting a band of single ornament in one course of this portion of the wall; not half-way, for to divide any portion of a building into mere "halves" has usually a weak and monotonous effect, but about two-thirds of the distance from the base line; and this band of ornament not only breaks up the plain surface a little, but also, by carrying another horizontal line along the wall, emphasises its horizontality. Always emphasise that which is the essential characteristic of your structure. A wall of this kind is essentially a long horizontal boundary; emphasise its length and horizontality. If we are millionaires, and can afford to spend a great deal on a wall, we may not only (Fig. 3) carry further the treatment of the coping and base, by giving them ornamental adjuncts as well as mouldings, but we might treat the whole wall-superficies as a space for surface carving, not mechanically repeated, but with continual variation of every portion, so as to render our wall a matter of interest and beauty while retaining all its usefulness as a boundary, observing that such surface ornament should be designed so as to fulfil a double object, (1st) to give general relief to the surface of the wall; (2nd) to afford matter of interest to the eye on close inspection and in detail. That is the double function of nearly all architectural ornament: it is, in the first place, to aid the general expression and balance of the building, and give point and emphasis where needed; and, in the second place, to furnish something to the eye for study on its own account when viewed more closely.

We will take another typical and simple erection, a stone pillar to support the ends of two lintels or beams. This may be simply a long squared piece set on end (Fig. 4), and will perform its constructive functions perfectly well in that form; but it is not only absolutely expressionless, but is in in one sense clumsy and inconvenient, as taking up more space than need be, presenting an unwieldly-looking mass when viewed at an angle, and shutting out a good deal of light (if that happen to be a matter of practical consequence in the case). Cutting off the angles (Fig. 5) does not weaken it much, and renders it much less unwieldly-looking, besides giving it a certain degree of verticality of expression, and rendering it more convenient as taking up less room and obstructing less light. But though the column is quite strong enough, the octagonal top does not make so good a seat or bearing for the ends of the lintels; we will therefore put a flat square stone on the top of it (Fig. 6) which will serve as a bed for the lintels to rest on securely. But the angles of this bed-plate, where they project beyond the face of the column, appear rather weak, and are so actually to some extent—a double defect, for it is not enough in architecture that a thing should be strong enough, it is necessary that it should appear so, architecture having to do with expression as well as with fact. We will, therefore, strengthen this projecting angle, and correct the abruptness of transition between the column and the bed-plate by brackets (Fig. 7) projecting from the alternate faces of the column to the angles of the bed-plates. As this rather emphasises four planes of the octagon column at the expense of the other four, we will bind the whole together just under the brackets by a thin band of

* The dark-shaded portion in this and the next two diagrams show the "section" of the wall as seen if we cut it through and look at it end-wise."

ornament constituting a necking, and thus we have something like a capital developed, a definitely designed finish to our column, expressive of its purpose. This treatment of the upper end, however, would make the lower end rising abruptly from the ground seem very bare. We will accordingly emphasise the base of the column, just as we emphasised the base of the wall, by a projecting moulding, not only giving expression to this connection of the column with the ground, but also giving it the appearance, and to some extent the reality, of greater stability, by giving it a wider and more spreading base to rest on. We have here still left the lines of one column vertically parallel, and there is no constructive reason why they should not remain so; there is, however, a general impression to the eye both of greater stability and more grace arising from a slight diminution upward. It is difficult to account for this on any metaphysical principle, but the fact has been felt by most nations which have used a columnar architecture, and we will accept it and diminute (so to speak) our column (Fig. 8). We have here taken a further step by treating the shaft of the column in two heights, keeping the lower portion octagonal and reducing the upper portion to a circle, and we now find it easier to treat the capital so as to have a direct and complete connection with the column, the capital being here merely a spreading out of the column into a bracket form all round, running it into the square of the bedplate.* The spreading portion is emphasised by surface ornament, and the necking is again emphasised, this time more decisively, by a moulding, forming a series of parallel rings round the column. If we wish to give our column an expression of more grace and elegance, we can further reduce the thickness of it (Fig. 9), and give more spread to the capital, always taking care to be sure that the strength of the column is not reduced below what the weight which it has to carry requires. In this case a bracket is shown above the capital, projecting longitudinally only (in the direction of the lintel bearing), a method of giving a larger bearing surface for the ends of the lintels, shortening their actual bearing† (in other words, widening the space which can be bridged between column and column), and giving a workmanlike appearance of stability to the construction at this point. The idea of the division of the column into two sections, suggested in Fig. 8, is kept up in Fig. 9, by treating the lower portion, up to the same height with incised decorative carving. The dotted lines on each side in Fig. 9 give the outline of the original square column as shown in Fig. 4. The finished column was within that block; it is the business of the architectural designer to get it out.*

Let us see if we can apply the same kind of process of evolving expression in regard to a building. We will take again the very simplest form of building (Fig. 10), a square house with a door in the centre and uniform rows of windows. There cannot be said to be any architectural expression in this; there is no base or plinth at all, no treatment of the wall; the slight projection at the eaves is only what is necessary to keep the rain from running down the walls, and facilitate the emptying of the gutters, and the even spacing of the windows is essential for constructive reasons, to keep the masses of wall over each other, and keep the whole in a state of equally balanced pressure. The first thing we should do in endeavouring to give some expression to the building would be to give it a base or plinth (Fig. 11), and to mark that and the cornice a little more decidedly by mouldings and a line of panelling at the plinth. The house being obviously in three storeys, we should give it some echo externally of this division into horizontal stages by horizontal mouldings, or what are called in architectural phraseology, "string courses," not necessarily exactly at the floor-levels, but so as to convey the idea of horizontal division; observing here, as in the case of the wall and column, that we should take care not to divide the height into equal parts, which is very expressionless. In this case we will keep the lower string close down on the ground-floor windows, and keep these rather low, thus showing that the ground-floor apartments are not the most important; while the fact that the first-floor ones are so is conversely made apparent by keeping these

* This is the feature called "abacus" (*i.e.*, "tile") in Greek architecture, but I am here considering it apart from any special style or nomenclature.

† "Bearing," in building language, is used in a double sense, for the distance between the points of support, and the extent to which the beam rests on the walls. Thus a beam which extends 20 feet between the points of support is a beam of 20 feet bearing; if the beam is 22 feet long, so that 1 foot rests on the walls at each end, it has "1 foot bearing on the wall."

* None of the forms of column sketched here have any existence in reality; they are purposely kept apart from imitation of accepted forms, to get rid of the idea that architecture consists in the acceptance of any particular form sanctioned by precedent.

windows rather higher, putting a double string-course over them, and a slight extra depth of moulding, forming a kind of cornice, over each. The space left between these and the roof, in which the attic windows are placed, is treated with a series of mullions and panellings, into which the attic windows are worked, as part of the series of openings; this gives a little richness of effect to the top storey, and a continuity of treatment, which binds the whole series of windows together. To have treated the whole of the walls and windows in this way would have been merely throwing away labour; what little effect it has consists in the "character" given by the contrast of this top-storey treatment with the plain wall surfaces below. The last thing is to emphasise the door, as the principal opening in the walls, and quite distinct in use and meaning from the other openings, by giving it a little architectual frame or setting, which may be done in many ways, but in this case is done by the old-fashioned device (not very logical certainly) of putting a little entablature over it, and a column on either side; there is, however, this to be said for it, that the projecting tablature forms a semi-porch, protecting those at the door somewhat from rain; it must be carried in some way, and columns are the readiest and most seemly manner of doing it, and they also form, practically, something of a weather screen; the bases on which they stand also form a framework or enclosing wall for the steps, which are thus made part of the architectural design, instead of standing out as an eyesore, as on Fig. 10. We have now given the house a little general expression, but it still is vague in its design as far as regards the distribution of the interior; we do not know whether the first floor, for instance, is one large room, or two or more rooms, or how they are divided; and the little house is very square and prim in effect. Let us try grouping the windows a little, and at the same time breaking up the flat surface of the front wall (Fig. 12). Here as before, we have divided the building by a horizontal string, but only by one main one on the first floor level, keeping the same contrast, however, between a richer portion above and a plainer portion below; we have divided the building vertically, also, by two projecting bays finishing in gables, thus breaking also the skyline of the roof, and giving it a little picturesqueness, and we have grouped the windows, instead of leaving them as so many holes in the wall at equal distances. The contrast between the ground and first floor windows is more emphatic; and it is now the more evident that the upper floor rooms are the best apartments, from their ample windows; it is also pretty evident that the first floor is divided into two main rooms with large bay windows, and a smaller room or a stair-case window, between them; the second floor windows are also shifted up higher, the two principal ones going in to the gables, showing that the rooms below them have been raised in height. Windows carried up the full height of these rooms, however, might be too large either for repose internally, or for appearance externally, so the wall intervening between the top of these and the sill of the gables is a good field for some decorative treatment, confined to the bays, so as to assist in separating them from the straight wall which forms the background to them.

So far we have treated our building only as a private house. Without altering its general scale and shape, we may suggest something entirely different from a private house. On Fig. 13, we have tried to give a municipal appearance to it, as if it were the guildhall of a small country town. The plain basement and the wide principal doorway, and the row of three very large equal spaced windows above, render it unquestionable that this is a building with a low ground storey, and one large room above; a certain "public building" effect is given to it by the large and enriched cornice wtth balustrade above and panelling below, and by the accentuation of the angles by projecting piers, and by the turrets over them, which give it quite a different character from that of a private house. If, on the other hand, the building were the free library and reading room of the same small country town, we should have little doubt of this, if we saw it as in Fig. 14, with the walls all blank (showing that they are wanted for ranging something against, and cannot be pierced for windows), and windows only in the upper portion. Similarly, if we want to build it as the country bank, we should have to put the large windows on the ground floor, bank clerks wanting plenty of light, and the ground storey being always the principal one; and we might indulge the humour of giving it a grim fortress-like strength by a rusticated plinth (*i.e.*, stones left or worked rough and rock-like), and by very massive piers between the windows, and a heavy cornice over them; the residential upper floor forming a low storey subordinate to the bank storey. It is true this would not

satisfy a banker, who always wants classic pilasters stuck against the walls, that being his hereditary idea of bank expression in architecture.

Now if we proceed to take to pieces the idea of architectural design, and consider wherein the problem of it consists, we shall find that it falls into a fourfold shape. It consists first in arranging the plan; secondly, in carrying up the boundary lines of this plan vertically in the shape of walls; thirdly, in the method of covering in the space which we have thus defined and enclosed; and, fourthly, in the details of ornamentation which give to it the last and concluding grace and finish. All building, when it gets beyond the mere wall with which we began, is really a method of covering in a space, or, if we may put it so, a collection of spaces, marked out and arranged for certain purposes. The first thing that the architect has to do is to arrange these spaces on the ground so that they may conveniently meet the necessary requirements of the building. Convenience and practical usefulness come first; but in any building which is worth the name of architecture something more than mere convenience has to be kept in mind, even in the arrangement of the plan upon the site. It is to be a combination of convenience with effectiveness of arrangement. We shall probably find that some one compartment of the plan is of paramount importance. We have to arrange the interior so that this most important compartment shall be the climax of the plan. The entrance and the other subsidiary compartments must be kept subordinate to it, and must lead up to it in such a manner that the spectator shall be led by a natural gradation from the subsidiary compartments up to the main one, which is the centre and *raison d'être* of the whole—everything in the lines of the plan should point to that. This is the great *crux* in the planning of complicated public buildings. A visitor to such a building, unacquainted with it previously, ought to have no difficulty in finding out from the disposition of the interior which are the main lines of route, and when he is on the line leading him up to the central feature of the plan. There are public buildings to be found arranged on what may be called the rabbit-warren system, in which perhaps a great number of apartments are got upon the ground, but which the visitor is obliged laboriously to learn before he can find his way about them. That is not only inconvenient but inartistic planning, and shows a want of logic and consideration, and, in addition to this, a want of feeling for artistic effect. I saw not long ago, for instance, in a set of competitive designs for an important public building, a design exhibiting a great deal of grace and elegance in the exterior architectural embellishment, but in which the principal entrance led right up to a blank wall facing the entrance, and the spectator had to turn aside to the left and then to the right before finding himself on the principal axis of the plan. That is what I should call inartistic or unarchitectural planning. The building may be just as convenient when you once know its dodges, but it does not appear so, and it loses the great effect of direct vista and climax. An able architect, who had given much thought to a plan of a large building of this kind, said to me, in showing me his plan, with a justifiable gratification in it, "It has cost me endless trouble, but it *is* a satisfaction to feel that you have got a plan with backbone in it." That is a very good expression of what is required in planning a complicated building, but few outsiders have any notion of the amount of thought and contrivance which goes to the production of a plan "with backbone;" a plan in which all the subordinate and merely practical departments shall be in the most convenient position in regard to each other, and yet shall all appear as if symmetrically and naturally subordinate to the central and leading feature; and if the public had a little more idea what is the difficulty of producing such a plan, they would perhaps do a little more justice to the labours of the man who contrives the plan, which they think such an easy business; and no doubt it may appear an easy business, because the very characteristic of a really good plan is that it should appear as if it were quite a natural and almost inevitable arrangement. Just as it is said in regard to literature, that easy writing is hard reading, so, in regard to planning, it is the complicated and rabbit-warren plans that are the easiest to make, because it is just doing what you please; it is the apparently perfectly simple and natural plan which springs from thought and contrivance. Then there is the next step of raising the walls on the plan, and giving them architectural expression. This must not be thought of as an entirely separate problem, for no truly architectural intellect will ever arrange a plan without seeing generally, in his mind's eye, the superstructure which he intends to rear upon it; but the

detailed treatment of this forms a separate branch of the design. Then comes the third and very important problem—the covering in of the space. Next to the plan this is the most important. All building is the covering over of a space, and the method of covering it over must be foreseen and provided for from the outset; it largely influences the arrangement of the plan. If there were no roofing you could arrange the walls and carry them up pretty much as you chose, but the roofing of a large space is another matter, it requires extra strength at certain points, where the weight of the roof is concentrated, and it has to be determined whether you will employ a method of roofing which exercises only a vertical pressure on the walls, like the lid of a box, or one which, like an arch, or a vault, or a dome, is abutting against the walls, and requires counterforts to resist the outward thrust of the roof. We shall come upon this subject of the influence of the roof on the design of the substructure more in detail later on. Then, if the plan is convenient and effective, the walls carried up with the architectural expression arising from the placing and grouping of the openings, and the proper emphasising of the base and the cornice, and the horizontal stages (if any) of the structure, and the roof firmly and scientifically seated on the walls; after all these main portions of the structure are designed logically and in accordance with one another, and with the leading idea of the building, then the finishing touches of expression and interest are given by well designed and effective ornamental detail. Here the designer may indulge his fancy as he pleases, as far as the nature of the design is concerned, but not, if you please, as far as its position and distribution are concerned. There the logic of architecture still pursues us. We may not place ornament anywhere at haphazard on a building simply because it looks pretty; at least, to do so is to throw away great part of its value. For everything in architectural design is relative; it is to be considered in relation to the expression and design of the whole, and ornament is to be placed where it will emphasise certain points or certain features of the building. It must form a part of the grouping of the whole, and be all referable to a central and predominating idea. A building so planned, built, and decorated, becomes in fact what all architecture—what every artistic design in fact should be—an organised whole, of which every part has its relation to the rest, and from which no feature can be removed without impairing the unity and consistency of the design. You may have a very good, even an expressive building, with no ornament at all if you like, but you may not have misplaced ornament; that is only an excrescence on the design, not an organic portion of it.

I have thought that it would be of use to those who are unacquainted with architectural procedure in delineating architecture by geometrical drawings, if I took the opportunity of illustrating very briefly the philosophy of elevations, plans, and sections, which many non-professional people certainly do not understand. A simple model of a building, like that in Fig. 16, will serve the purpose, as the principle is the same in the most complicated as in the simplest building. It must be remembered that the object of architectural drawings on the geometrical system is not to show a picture of the building, but to enable the designer to put together his design accurately in all its parts, according to scale, and to convey intelligible and precise information to those who have to erect the building. A perspective drawing like Fig. 16 is of no use for this purposs. It shows generally what the design is, but it is impossible to ascertain the size of any part by scale from it, except that if the length of one line were given it would be possible, by a long process of projection and calculation, to ascertain the other sizes. The *rationale* of the architect's geometrical drawings is that on them each plane of the building (the front, the side, the plan, &c.) is shown separately and without any distortion by perspective, and in such a manner that every portion is supposed to be opposite to the eye at once. Only the width of any object on one side can be shown in this way at one view; for the width of the return side you have to look to another drawing; you must compare the drawings in order to find out those relative proportions which the perspective view indicates to the eye at a glance; but each portion of each side can be measured by reference to a scale, and its precise size obtained, which can only be guessed at roughly from the perspective drawing. Thus the side of the model is shown in Fig. 19, the end in Fig. 17; the two together give the precise size and proportions of everything outside to scale, except the projection of the pilasters; this has to be got at from the plan and section. Everything being drawn on one plane, of course surfaces

which are sloping on one elevation are represented as flat in the other; for instance, on No. 17, the raking line of the sloping roof is shown at N, so we know the slope of the roof, but we do not know to what length it extends the other way. This is shown on Fig. 19, where the portion showing the roof is also marked N, and it will be seen that the surface which is sloping in Fig. 17 is seen in the side elevation only as a space between a top and bottom line; we see the length of the roof here, and its height, but for its slope we go to the end elevation. Neither elevation tells us, however, what is inside the building; but the section (Fig. 18) shows us that it has an arched ceiling, and two storeys, a lower and a higher one. The section is the building cut in half, showing the end of the walls, the height and depth of the window openings, the thickness of the floor, &c., and as all parts which are opposite the eye are shown in the drawing, the inside of the cross wall at the end of the building is shown as a part of the section drawing, between the sectional walls. In Fig. 23 the section is sketched in perspective, to show more clearly what it means. Another section is made lengthways of the building (Fig. 20). It is customary to indicate on the plan by dotted lines the portion through which the section is supposed to be made; thus on the plans the lines A B and C D are drawn, and the corresponding sections are labelled with the same lines. As with the elevation, one section must be compared with another to get the full information from them. Thus in Fig. 18, the ceiling, M, is shown as a semicircle; in Fig. 20, it is only a space between the top and bottom line; it is, certainly, shaded here to give the effect of rotundity, but that is quite a superfluity. On Fig. 18 the height of the side windows is shown at F, and the thickness of the wall in which they are made; in Fig. 20 (F) their width and spacing are shown. In Fig. 18 some lines drawn across, one over the other, are shown at H; these are the stairs, of which in this section we see only the fronts, or risers, so that they appear merely as lines (showing the edge of each step) drawn one over the other. At H on the plan, Fig. 21, we again see them represented as a series of lines, but here we are looking down on the top of them, and see only the upper surfaces, or "treads," the edges again appearing as a series of lines. At H on the longitudinal section, we see the same steps in section, and consequently their actual slope, which, however, could have been calculated from Figs. 18 and 21, by putting the heights shown in section with the width shown in plan. The plan, Fig. 21, shows the thickness and position on the floor of the pillars G G; their height is shown in the sections. The plan of a building is merely a horizontal section, cutting off the top, and looking down on the sectional top of the walls, so as to see all their thicknesses. I have drawn (Fig. 24) a perspective sketch of one end of the plan (Fig. 22) of the building, on the same principle as was done with the section (Fig. 23), in order to show more intelligibly exactly what it is that a plan represents—the building with the upper lifted off.

Returning for a moment to the subject of the relation between the plan and the exterior design, it should be noted that the plan of a building being practically the first consideration, and the basis of the whole design, the latter should be in accordance with the principle of disposition of the plan. For example, if we have an elevation (shown in diagram) showing two wings of similar design on either side of a centre, designed so as to convey the idea of a grand gallery, with a suite of apartments on either side of similar importance—if the one side only of the plan contains such a suite, and the opposite side is in reality divided up into small and inferior rooms, filled in as well as may be behind the architectural design, the whole design is in that case only a blind or screen, giving a false exterior symmetry to a building which is not so planned. This is an extreme case (or might be called so if it were not actually of pretty frequent occurrence); but it illustrates in a broad sense a principle which must be carried out in all cases, if the architecture is to be a real expression of the facts of the building.

In this lecture, which is concerned with general principles, a word may fittingly be said as to the subject of *proportion*, concerning which there are many misapprehensions. The word may be, and is, used in two senses, first in regard to the general idea suggested in the words "a well-proportioned building." This expression, often vaguely used, seems to signify a building in which the balance of parts is such as to produce an agreeable impression of completeness and repose. There is a curious kind of popular fallacy in regard to this subject, illustrated in the remark which used to be often made about St. Peter's, that it is so well-proportioned that you are not aware of its great size, &c.;

a criticism which has been slain over and over again, but continues to come to life again. The fact that this building does not show its size is true; but the inference drawn is the very reverse of the truth—one object in architectural design is to give full value to the size of a building—even to magnify its apparent size; and St. Peter's does not show its size, because it is *ill*-proportioned, being merely like a smaller building with all its parts magnified; hence the deception to the eye, which sees details which it is accustomed to see on a smaller scale, and underrates their actual size, which is only to be ascertained by deliberate investigation. This confusion as to scale is a weakness inherent in the classical forms of columnar architecture, in which the scale of all the parts is always in the same proportion to each other, and to the total size of the building, so that a large Doric temple is in most respects only a small one magnified. In Gothic architecture the scale is the human figure, and a larger building is treated, not by magnifying its parts, but by multiplying them. Had this procedure been adopted in the case of St. Peter's, instead of merely treating it with a columnar order of vast size, with all its details magnified in proportion, we should not have the fault to find with it that it does not produce the effect of its real size. In another sense, the word "proportion" in architecture refers to the system of designing buildings on some definite geometrical system of regulating the sizes of the different parts. The Greeks certainly employed such a system, though there are not sufficient data for us to judge exactly on what principle it was worked out. In regard to the Parthenon, and some other Greek buildings, Mr. Watkiss Lloyd has worked out a very probable theory, which will be found stated in a paper in the "Transactions of the Institute of Architects."

Vitruvius gives elaborate directions for the proportioning of the size of all the details in the various orders; and though we may doubt whether his system is really a correct representation of the Greek one, we can have no doubt that some such system was employed by them. Various theorists have endeavoured to show that the system has prevailed of proportioning the principal heights and widths of buildings in accordance with geometrical figures, triangles of various angles especially; and very probably this system has from time to time been applied, in Gothic as well as in classical buildings. This idea is open to two criticisms, however. First, the facts and measurements which have been adduced in support of it, especially in regard to Gothic buildings, are commonly found on investigation to be only approximately true; the diagram of the section of the building has nearly always, according to my experience, to be "coaxed" a little in order to fit the theory; or it is found that though the geometrical figure suggested corresponds exactly with some points on the plan or section, these are really of no more importance than other points which might just as well have been taken; the theorist draws our attention to those points in the building which correspond with his geometry, and leaves on one side those which do not. Now it may certainly be assumed that any builders intending to lay out a building on the basis of a geometrical figure, would have done so with precise exactitude, and that they would have selected the most obviously important points of the plan or section for the geometrical spacing. In illustration of this point, I have given (Fig. 25) a skeleton diagram of a Roman arch, supposed to be set out on a geometrical figure. The centre of the circle is on the intersection of lines connecting the outer projection of the main cornice with the perpendiculars from those points on the ground line. This point at the intersection is also the centre of the circle of the archway itself. But the upper part of the imaginary circle beyond cuts the middle of the attic cornice. If the arch were to be regarded as set out in reference to this circle, it should certainly have given the most important line—the top line, of the upper cornice, not an inferior and less important line; and that is pretty much the case with all these proportion theories (except in regard to Greek Doric temples); they are right as to one or two points of the building, but break down when you attempt to apply them further. It is exceedingly probable that many of these apparent geometric coincidences really arise, quite naturally, from the employment of some fixed measure of division in setting out buildings. Thus, if an apartment of somewhere about 30 feet by 25 feet is to be set out the builder employing a foot measure naturally sets out exactly 30 feet one way and 25 feet the other way; it is easier and simpler to do so than to take chance fractional measurements. Then comes your geometrical theorist and observes that "the apartment is planned precisely in the proportion of six to five;" so it is, but it is only the philosophy of the

measuring-tape, after all. Secondly, it is a question whether the value of this geometrical basis is so great as has sometimes been argued, seeing that the results of it in most cases cannot be judged by the eye. If, for instance, the room we are in were nearly in the proportion of seven in length to five in width, I doubt whether any of us here could tell by looking at it whether it were truly so or not, or even, if it were a foot out one way or the other, in which direction the excess lay; and if this be the case, the advantage of such a geometrical basis must be rather imaginary than real.

Having spoken of plan as the basis of design, I should wish to conclude this lecture by suggesting also, what has never to my knowledge been prominently brought forward, that the plan itself, apart from any consideration of what we may build up upon it, is actually a form of artistic thought, of architectural poetry, so to speak. If we take three such plans as those shown in Figs. 26, 27, and 28, typical forms respectively of the Egyptian, Greek, and Gothic plans, we certainly can distinguish a special imaginative feeling or tendency in each of them. In the Egyptian, which I have called the type of "mystery," the plan continually diminishes as we proceed inwards; in the third great compartment the columns are planted thick and close so as to leave no possibility of seeing through the building except along a single avenue of columns at a time; the gloom and mystery of a deep forest are in it, and the plan finally ends, still lessening as it goes, in the small and presumably sacred compartment to which all this series of colonnaded halls leads up. In the Greek plan there is neither climax nor anti-climax, only the picturesque feature of an exterior colonnade encircling the building and surrounding a single oblong compartment; it is a rationalistic plan, aiming neither at mystery nor aspiration. In the plan of Rheims (Fig. 28) we have the plan of climax or aspiration; as in the Egyptian, we approach the sacred portion through a long avenue of piers; but instead of narrowing, the plan extends as we approach the shrine. I think it will be recognised, putting aside all considerations of the style of the superstructure on these plans, that each of them in itself represents a distinct artistic conception. So in the plan of the Pantheon (Fig. 29), this entrance through a colonnaded porch into a vast circular compartment is in itself a great architectural idea, independently of the manner in which it is built up.

We may carry out this a little further by imagining a varied treatment on plan of a marked-out space of a certain size and proportion, on which a church of some kind, for instance, is to be placed. The simplest idea is to enclose it round with four walls as a parallelogram (Fig. 30), only thickening the walls where the weight of the roof-principals comes. But this is a plan without an idea in it; the central or sacred space at the end is not expressed in the plan, but is merely a railed-off portion of the floor; the entrance is utterly without effect as well as without shelter. If we lay out our plan as in Fig. 31, we see that there is now an idea in it. The two towers, as they must evidently be, form an advanced guard of the plan, the recessed central part connecting them gives an effective entrance to the interior; the arrangement in three aisles gives length, the apse at the end encloses and expresses the *sacrarium*, which is the climax and object of the plan. The shape of the ground, however, is not favourable to the employment of a long or avenue type of plan, it is too short and square; let us rather try a plan of the open area order, such as Fig. 32. This is based on the short-armed Greek cross, with an open centre area; again there is an "advanced guard" in the shape of an entrance block with a porch; and the three apses at the end give architectural emphasis to the *sacrarium*. Fig. 35 is another idea, the special object of which is to give an effect of contrast between the entrance, approached first through a colonnaded portico, then through an internal vestibule, lighted from above, and flanked by rows of small coupled columns; then through these colonnaded entrances, the inner one kept purposely rather dark, we come into an interior expanding in every direction; an effect of strong contrast and climax. If our plot of ground again be so situated that one angle of it is opposite the vista of two or more large streets, there and nowhere else will be the salient angle, so to speak, of the plan, and we can place there a circular porch — which may, it is evident, rise into a tower—and enter the interior at the angle instead of in the centre; not an effective manner of entering as a rule, but quite legitimate when there is an obvious motive for it in the nature and position of the site. A new feature is here introduced in the circular colonnade dividing the interior into a central area and an aisle. Each of these plans might be susceptible of many different styles of architectural treatment; but quite

independently of that, it will be recognised that each of them represents in itself a distinct idea or invention, a form of artistic arrangement of spaces, which is what "plan," in an architectural sense, really means.

Miscellaneous.

THE PRIVILEGES OF JEWS IN RUSSIA.

The United States Consul-General at St. Petersburg says that the laws and regulations affecting the rights, privileges, and immunities of foreign Jews in the Russian empire are numerous, and are different in the various provincial governments of the empire. Foreign Jews are prohibited from living in Russia unless they avowedly come for the purpose of entering into commerce on an extensive scale. The only exception to this rule is embraced in the Ukase of 1831, whereby rabbis and men of letters of foreign nationalities sent on behalf of their governments are excepted. As to the legislation for Jews, the empire is divided into two great divisions, one where Jews may reside, and the other where they cannot. The following are the districts where Jews may live, and where they enjoy comparatively few restrictions. The governments of Vilna, Volhynia, Grodno, Ekaterinoslav, Cherson, Kovno, Minsk, Mohilieff, Poltava, Podolia, Tchernagoff, Bessarabia, and Vitebsk. In the two latter governments, Jews may live in the villages only if permission is granted to them temporarily, and they are not allowed to live there as permanent inhabitants. They may reside in the kingdom of Poland, namely, the governments of Warsaw, Lomsha, Plotsk, Kalisch, Pietrokoff, Lublin, Suvalki, and Radom. The government of Kieff, with the exception of the town of Kieff, and the government of Taurida, with the exception of the town of Sebastopol, are also free to the Jews, provided that they do not live in these governments within forty miles of the frontier. In Odessa, Jews are only allowed to live who were established there on the 9th October, 1859, and who have always had, and still have, a trade or industry of some description. In the government of Courland, colony of Schloek-Livonia, Jews may only live if their names have appeared in the lists of the records of the population prior to the year 1835. In Riga, Jews may only live who have had fixed abode prior to the 17th December, 1861. They are prohibited from residing in any other part of Russia. The conditions under which foreign Jews are admitted into Russia are different, and depend upon whether their abode is intended to be temporary or permanent. Before entering the empire a Jew must obtain permission of a Russian official abroad—an ambassador or consul. If this is refused, he can appeal to the Russian Department of the Interior, in which application he must state his purpose and motive for the desired visit· if he obtains permission, the following conditions are required to be fulfilled. In the Jew regions of Russia, the abode for not more than six months is allowed to the foreign Jew on condition that all the necessary formalities are complied with. He is not allowed to remain more than six months, unless he has obtained the permit of the Governor-General of the Province, and after having taken a patent of a merchant of the first guild. For an abode of more than a year, or to establish himself permanently, the foreign Jew must have the permit of the Ministry of Finance, or of the Interior or Foreign Affairs, and take at the same time a patent of first guild merchant. Foreign Jews who wish to visit the parts of Russia outside the Jewish region, without having the direct purpose to trade, must have the permission of the Department of the Interior. If they wish to combine with their visit, although it may be for a limited time, the right to trade or do business there, they must, in order to take a patent as a merchant of first guild, obtain the permission of the Ministers of Finance, Interior, or Foreign Affairs, and the stipulation concerns only foreign Jews who desire to trade, and to establish themselves permanently as traders beyond the Jewish regions. The application to be classed as a merchant of first guild, which must be addressed to one of the above-mentioned ministries, must be accompanied by a declaration and by a statement that the Jew in question is in a good position in his own country, and that he has a large business. It is not stipulated by whom this statement is made; it may be made by the Governor-General of the government where he wishes to establish himself, by the committee of trade, or by a foreign authority, and in some cases the statement is made by a well-known commercial firm with which the Jew has business relations. Foreign Jews are, in the same way as all other foreigners, obliged to observe the same regulations of the passport system. Consul-General Yonng says that the Russian Government does not admit that the commercial treaties concluded between Russia and foreign powers give the right to demand that the Jewish subjects or citizens of the latter should be treated on the same footing as the Russian Jews. Foreign Jews have to submit to all legal restrictions stipulated for Russian Jews, as for instance the payment of a special tax; they cannot enter the nobility, and their children must attend special Jewish schools. It appears that a commission was some time since appointed by the Russian Government to reform and assuage legislation for the Jews in the empire, but Consul Young says that the commission has not yet agreed upon a code of laws and regulations, although it is probable that a more lenient code will be proposed than now exists.

FRENCH TELEGRAPHS.

The *Journal des Chemins de Fer* states that the telegraphic communication between Paris, the various departments, and foreign countries is as follows:— Six wires connect Marseilles and Paris, Bordeaux and Lyons have each four wires, Lille, Brest, and Toulouse have each three, while Amiens, Montpelier, and Nantes have two wires. All the other prefectures are each connected with Paris by a direct wire, with the exception of Tulle, Quimper, Mont-de-Marsau, Foix, Carcassonne, Privas, Gap, Digne, Mende, and Ajaccio, which are not yet connected with Paris, but are expected to be within a very short time. Between Paris and London there are twelve wires, and two direct wires from Marseilles to London. The connection with Germany is with ten wires, four of which are with Berlin, two with Frankfort, one with Cologne, one with Hamburg, one with Strasburg, and one with Mulhouse. Metz is not connected with Paris. For Austria there are three wires—two with Vienna and the third with Bregenz. For Belgium there are four wires, two with Brussels and two with Antwerp. Denmark is directly connected with Paris by a submarine cable from Fredericia to Calais. With Spain there is only one wire—to Madrid, and the connection with Holland consists of two wires to Amsterdam. There are six wires connecting France with Italy—two with Rome, one with Florence, one with Turin, one with Genoa, and one with Milan. Between Switzerland and France there are four wires—two with Geneva, one with Bale, and one with Berne.

Notes on Books.

Pen and Pencil in Asia Minor, or Notes from the Levant. By William Cochrane. London: Sampson Low, Marston, Searle, and Rivington. 1887. 8vo.

This work, in addition to a description of the author's travels, contains a considerable amount of information respecting sericulture, a subject upon the elucidation of which Mr. Cochrane has spent many years of labour, and respectiug which he read a paper before the Society of Arts, in January, 1882. The fourth chapter is devoted to a description of the preliminaries of the silk harvest, the fifth to the growth of the mulberry, the sixth to graine distribution, and the seventh to the silkworm nursery. The ninth chapter contains an account of Mr. John Griffitt's experiences in the education of the silkworm, and the eleventh has twelve rules for the guidance of sericulturists in the successful reproduction of silkworms. The diseases of the silkworm are described in the thirteenth chapter, and the fourteenth chapter is devoted to the consideration of the use of the microscope in sericulture. The subjects of the nineteenth chapter is the Bournabat Silk Harvest of 1885, in which the author describes how Mr. Griffitt revived a remunerative industry. The book is fully illustrated by engravings from Mr. Cochrane's drawings.

The Chemists' and Druggists' Diary, 1888, including Pharmacologia or Legal Compendium for Chemists and Druggists. London. 4to.

This diary, published in connection with the *Chemist and Druggist*, besides the legal compendium mentioned in the title-page, contains much general information, and a large number of illustrated advertisements of druggists' specialities, &c.

The British and Colonial Druggists' Diary, 1888. 4to.

A similar publication to the above, which contains, besides a large collection of advertisements, information on various subjects connected with the trade of the druggist, and useful tables.

General Notes.

City and Guilds of London Institute.—Dr. A. K. Miller will deliver a course of ten lectures on the "Chemistry of Oils and Fats," at the Central Institution, Exhibition-road, on Mondays, at 4 p.m., during the spring term, commencing on January 23rd, 1888. The lecturer will treat of—I. Oils of mineral origin; petroleum, including shale oil, paraffin, and manufacture of oil gas; II. Oils, fats, &c. of vegetable and animal origin, volatile oils, including turpentine, fixed oils and fat.

Froebel Society.—A course of lectures will be given by this Society in connection with the Examination, &c., for the elementary certificate, July, 1888, at the School-room, St. Martin's, Charing-cross. This course will consist of an introductory address by Miss Emily Lord, on January 14th, and 40 lectures, viz.: 10 on "Principles and Methods of Pestalozzi and Froebel," by Miss Clarke, on Saturdays, January 21st to March 24th, from 10 to 11 a.m. Ten on "Zoology," by Miss Beatrice Wallick, on Saturdays, January 21st to March 24th, from 12 to 1 p.m. Ten on "Gifts and Occupations," by Miss Pattison, on Saturdays, April 28th to June 31st, from 10 to 11. Ten on "Botany," by Miss Martin, on Saturdays, April 28th to June 31st, from 12 to 1.

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FRIDAY, DECEMBER 30, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first lecture of the usual short course adapted for a juvenile audience will be given by Mr. William Henry Preece, F.R.S., on the "Application of Electricity to Lighting and Working," on Wednesday next, January 4th, at seven o'clock. The second lecture will be given on January 11th.

All the tickets for these lectures having now been disposed of, the issue is stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket. Any member who has received a ticket which he cannot make use of will confer a favour by returning it to the Secretary.

MOTORS FOR ELECTRIC LIGHTING

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for October 28th.

The competition will take place in London about May or June, 1888. To-morrow, December 31st, is the last day for receiving entries.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ELEMENTS OF ARCHITECTURAL DESIGN.

By H. H. Statham.

Lecture II.—Delivered December 5, 1887.

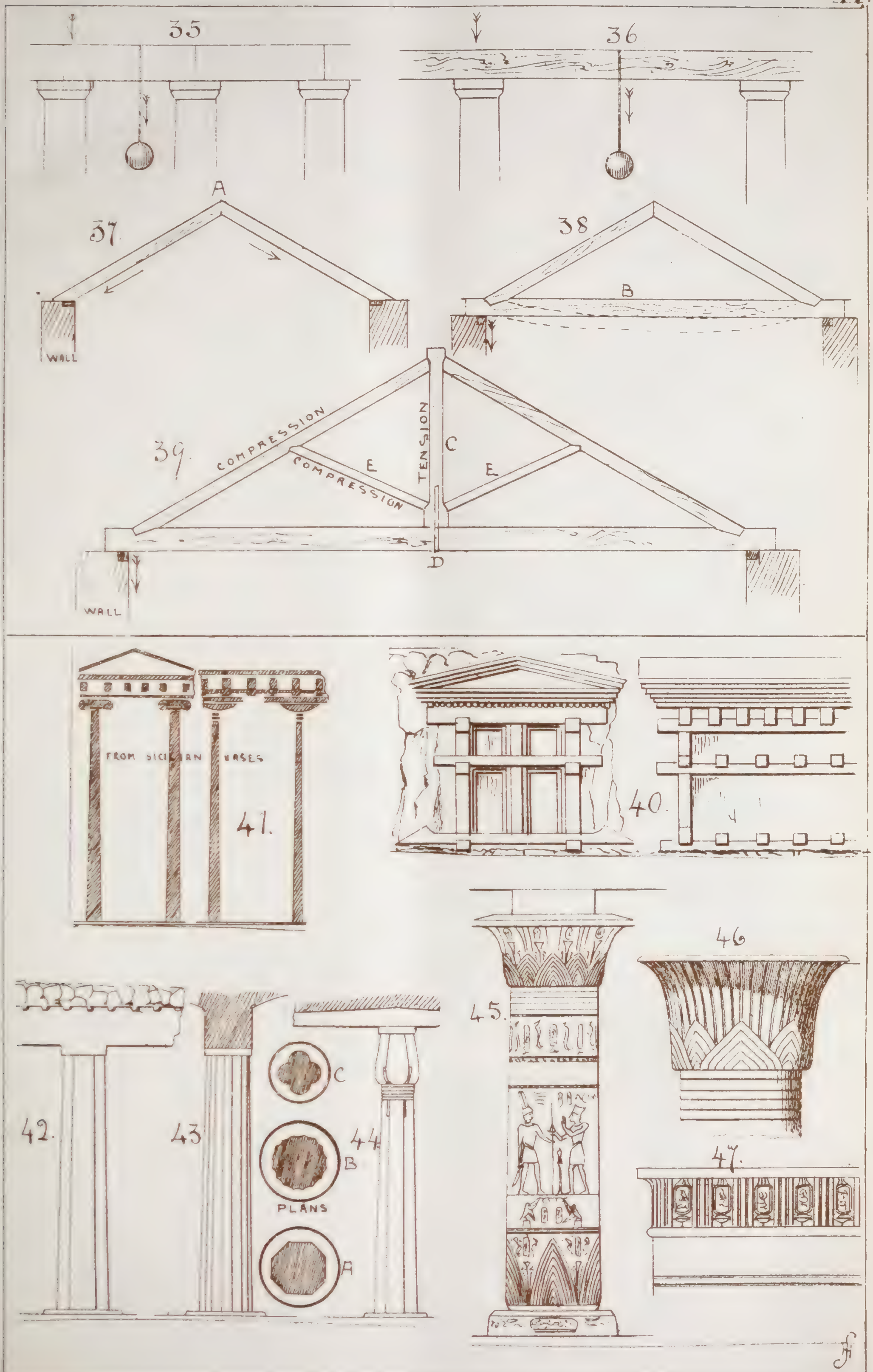
[The illustrations to this lecture are issued as a Supplement to the present number of the *Journal*.]

In the previous lecture, reference was made to the influence of the roofing of a building upon the substructure, and it was pointed out generally how the walls must be arranged and massed in reference to the manner and the positions in which the principal weight of the roof came on them. Considering this more specially, we may say that all roofing may be classed constructively under two heads; that which consists in covering a space by a beam laid across from one point of support to another, and which therefore exercises a simple vertical pressure on the walls, and that which consists in an arrangement of stones or other similar material in the form of an arch, which exercises an outward thrust upon the walls in a manner to be considered in our next lecture. In Mr. Garbett's little book on the "Principles of Design in Architecture," a work containing more real thought on the subject in proportion to its size than any other architectural treatise I am acquainted with, it has been attempted to show that there is a third principle, which the author says is destined to produce the architecture of the future, viz., the arch with its points of springing confined by a cross tie of iron or other tensile material, so that the tie-rod holds the arch together, and receives the thrust of it, which would otherwise be conveyed to the walls. I think, however, that we can hardly accept this view of the arch and tie as a separate constructive principle in architecture, influencing style; because in reality such an arch, so far as its bearing on the substructure is concerned, is only a more complex form of beam, exercising a purely vertical pressure on the walls. There are other complex forms of beams, which all come under the same category in an architectural sense, being a method of framing timbers or other materials together so as to mutually support each other, and to bridge over a larger space with less bulk of material than could be achieved by merely using the material in the simple form of a single beam. This is accom-

plished by the principle of the truss, which is so important a feature in roofing construction, and in bridging over spaces generally, that a brief explanation of it will be desirable before proceeding with our subject.

If we suppose a set of stone lintels laid across from one column to another, as in Fig. 35 (which is the typical Greek construction), the pressure of the wall above them, which operates in the same way as a weight hung to them and pulling them down, is acting directly across the line of the longer axis of the lintel, tending to break it in two across the middle; in other words, it is subjected to what is spoken of as "cross-strain." This is the most disadvantageous strain to which a piece of material of the shape and consistency of a stone lintel can be subjected; in plain words, it is more easily broken that way than any other; and though the strain upon it is much less when the pressure is distributed over the whole surface of the lintel, instead of being applied at one point only, as in the diagram, still a stone lintel subjected to that kind of pressure can only carry over a comparatively small space, and in columnar architecture of this type the distance between the columns is limited to the small distance which can be bridged over by a stone lintel. If we take a wooden lintel (Fig. 36) we can carry over a larger space, because wood, being a fibrous material, has more cohesion, and is less easily rent asunder than a granular material like stone. This fact is alluded to by Vitruvius as influencing the architectectural arrangement of temples in which wooden lintels are used. In roofing over large spaces, however, we can get no beam of timber which will carry over the whole space without bending with its own weight, and if we could procure pieces of timber of such size and depth as not to do so, they would be enormously heavy and unwieldy. If we take two pieces and let them lean against each other in the centre, their feet abutting against the wall (Fig. 37), we get a step farther, but we have now the disadvantage that the weight of the two beams meeting at A is transformed into a pressure outwards against the walls, in the direction shown by the arrows, tending to push the walls out, and thereby let the centre, A, drop. If, instead of fixing the beams directly upon the walls, we let them into a horizontal beam, B, we have got rid of the outward thrust on the walls, and the whole now only acts vertically, in the same way as the ordinary beam, but we have still the same tendency of the cross-beam to bend by its own weight, in the direction of the dotted lines at B; and the only advantage we have so far got is that we have secured the sloping form necessary for a roof, without its exercising the same outward pressure on the walls as in Fig. 37. Still, when B begins to sink, the tendency will be again for the construction to sink inside the walls, and press them outwards. But if, instead of merely letting the two sloping pieces meet at the top, we place between them a vertical piece, C (Fig. 39), so cut that it shall be clipped between the tops of the two sloping pieces, we can then, by means of this vertical piece (called the "king-post"), hold up the middle of the horizontal beam (called the "tie-beam") and give it support against sinking. All the four pieces in the construction are now, so to speak, jammed together immovably. The feet of the sloping pieces ("rafters") are fixed immovably in the substance of the tie-beam, the heads are jammed together against the king-post, and cannot sink unless the tie-beam sinks, and draws down the whole construction, and the tie-beam is prevented from sinking by being held up to the king-post, to the post of which it is attached by an iron strap, or other method. The thing is really, it will be observed, an opposition of pressures, which neutralise each other. The sloping rafters are in compression in the direction of their length, the king-post is in a state of tension, or resistance to a pulling strain, holding up in the centre the tie-beam which at its extremities holds the feet of the rafters. The tie-beam itself is under a tension strain, for it is pulled apart by the thrust of the rafters, thus again opposing the compression strain on the rafters; and though it is still subject to the downward cross strain arising from its own weight and tending to make it sink in the middle, this is neutralised by a corresponding upward cross strain from the pull of the king-post. When the roof gets to such a size that the rafters in their turn have the same tendency to bend from their own weight, a fresh member is introduced in the shape of the strut (E E), which is in compression and is held up by the opposing tension of the king-post on which it is footed, while it holds up the middle of the rafter. The same principle may be carried into further elaboration by the introduction of fresh members of tension and compression as the span gets larger, and the strains on the separate portions more important and complicated, always on the principle of compensating

IV.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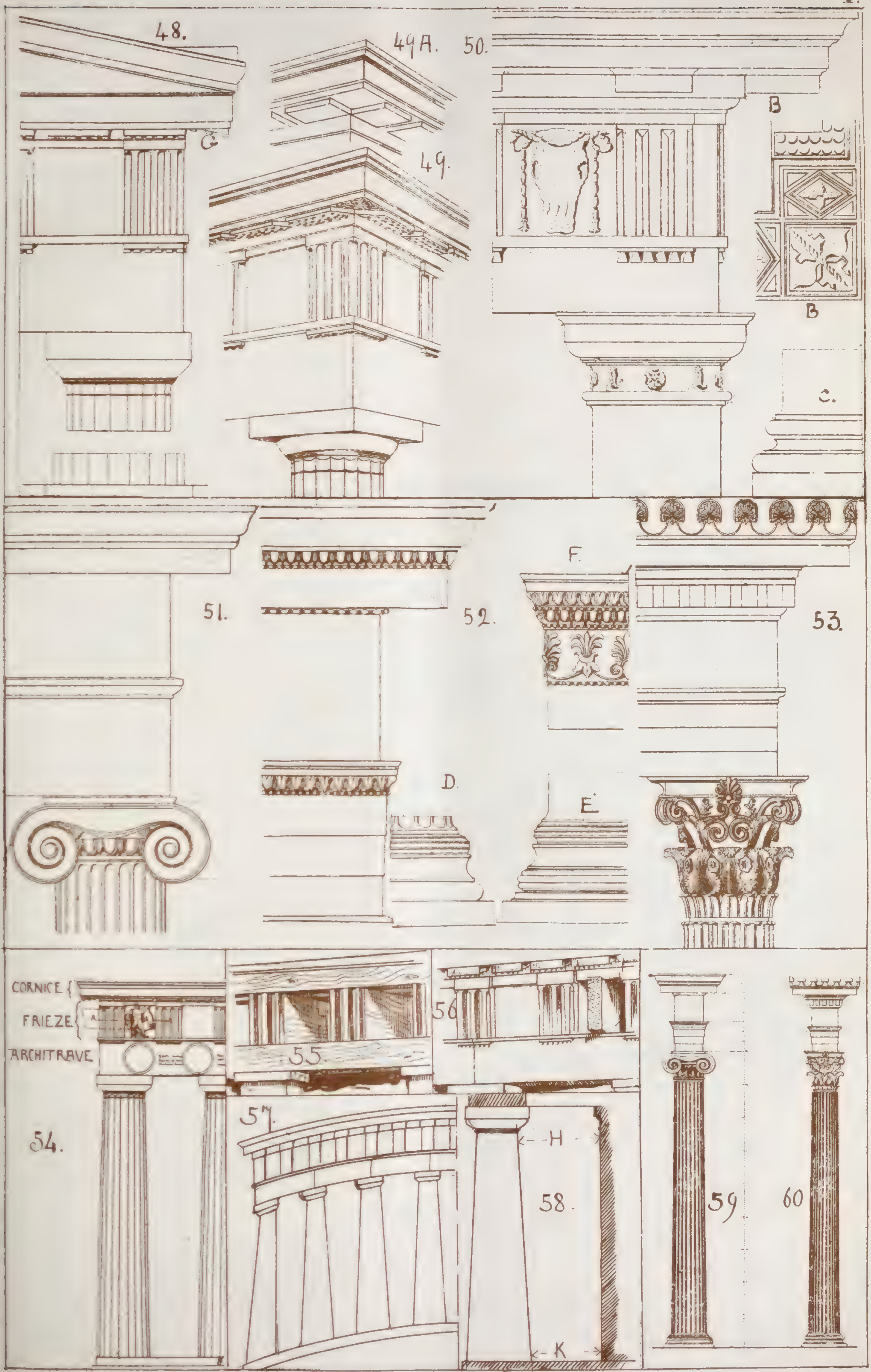
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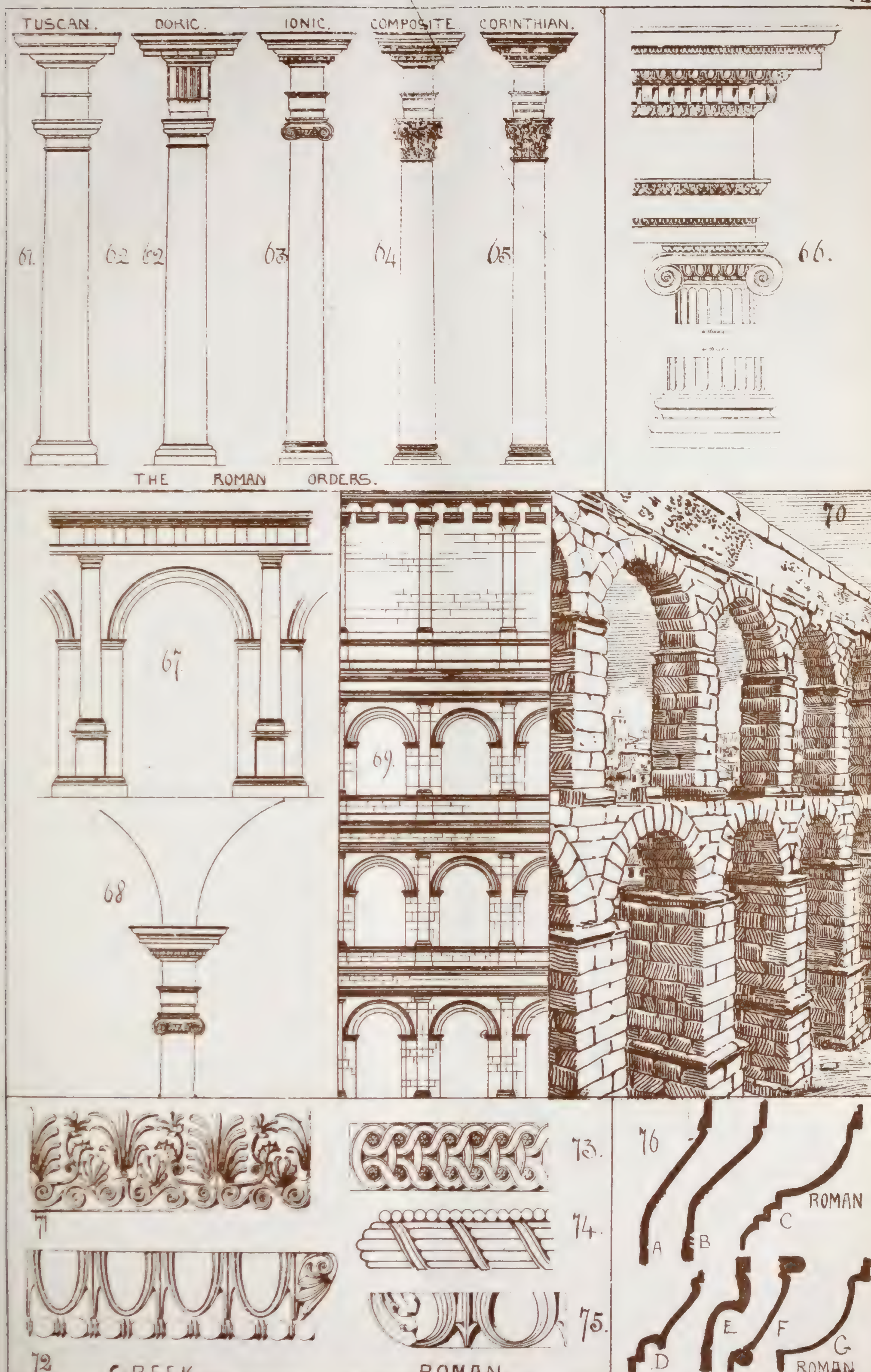
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strains in compression and tension to neutralise each other, and the forces exercised all acting within and limited to the structure itself, so that its only action on the walls is by the single weight of the combined pieces. Such a structure, however complicated in itself, is in its effect on architectural design only a beam—it belongs to trabeated construction (*Trabes* = a beam), and so does the much lighter and airy looking form of the iron truss, which, far as it is in appearance from the beam in its single form, fulfils just the same architectural function.

We have then before us two main systems of construction, the beam and the arch, each of which influences differently the arrangement of the plan, and each of which has its influence on style: and here may be the fitting place to devote a word to the question of what this expression "style" in architecture really means. I should define architectural style as implying a uniform system of construction, and the consistent expression of that construction in the design, combined with a consistency in regard to feeling, scale, and general treatment of the details, with suitability to their position. This latter desideratum may in itself go far to create the impression of style, even when the expression of construction is not entirely consistent. The brothers Adam, for instance, who built the Adelphi quarter in which the Society of Arts has its home, may have the credit of having invented or developed, if not quite a style, at least what may be called a sub-style, a treatment of classical detail which was new at the time, and which has the merit of general consistency of manner and feeling in the details. We can illustrate true style, too, in very simple objects of everyday use, if their forms and decorative treatment are based upon construction and use; for the element which we recognise as style is evident even in the harmony and consistency of decorative treatment, so long as there is nothing in the constructive material which clashes with the decorative consistency. But style in architecture is only fully and completely developed when it shows not only decorative consistency of taste, but when a uniform system of construction is adopted throughout the building, and that system is fully and consistently expressed in the design; and where features are admitted which in their apparent expression contradict the real fact of construction, the style is false and incomplete.

We shall find that these qualities both of true and of false style can be illustrated very fully from various types of existing architecture; and though it might be possible to illustrate the trabeated and arcuated styles by building up a form of architectural design, based on a pure theory, it is much easier, and certainly more instructive, to derive the illustration from styles which have existed, as in that case we not only illustrate the immediate subject in hand, but gain at the same time an insight into the historical relation of various architectural features, which is in itself a matter of considerable interest, and serves to illustrate further the manner in which architectural ideas have been developed. I therefore propose in this and the following lecture to illustrate the architectural treatment of the trabeated and arcuated systems of construction by the consideration of the Greek and Gothic styles, which are respectively the most complete types of architectural treatment of those two systems of construction.

The statical condition, then, of an architectural style founded on the lintel system of construction, is one in which all the strains on the supported portions are cross strains, all the pressures on the supporting portions are simple vertical pressures. Accordingly it is into these two main elements that the design of Greek architecture is resolved; it consists of the column, which is the support against vertical pressure, and the horizontal portion or "entablature," as it is technically called, which is laid across from column to column. It is true that in the actual Greek architecture there is an apartment within the colonnade, bnilt up with solid walls; but the constructive problem is here just the same; the wall is a continuous column, the roof is the lintel portion resting upon it; and æsthetically, to the Greek mind, the column and its entablature, the outer ordinance of the building, seem to have been practically the architecture; the walled portion or *cella* was architecturally of only secondary account.

The main portions of the Greek Doric order, which we will first consider, as being the most complete and refined in detail, as well as the most dignified in expression, of all the colonnaded styles, are shown in Fig. 41, showing the capital and base of the column only, and again in Fig. 54, on a smaller scale, and with the column shown at full length. It consists, as will be seen, of a column of rather massive proportions, with the sides channelled or fluted so as to give a series of vertical edges and shadow lines on the surface, with a

capital consisting of a thick massive abacus, and a moulding of finely-curved outline beneath it; this moulding is separated from the column by a group of horizontal lines formed by a series of delicate mouldings carried round the neck of the column, and with a subsidiary line formed beneath them a little way down the shaft of the column, by a narrow little nick cut into it and giving a thin black shadow line round it at this point. The entablature, above the column, is divided into three portions, which are labelled with their names in Fig. 54; first the *architrave*, or principal beam, with a perfectly plain surface, except for the projection or *fillet* on the upper edge of it; next the *frieze*, which in the Doric style consists of a series of upright pieces which are the real supports of the cornice, and which are channelled with two grooves down the face, and a half groove at each angle, these pieces being hence called *triglyphs*, or "three-grooved pieces;" and between them a series of much thinner slabs which fill the spaces between them, called *metopes*. The triglyph pieces go through the whole thickness of the wall, and are set with their narrower edge to the face; they are in fact short thick columns which carry the cornice blocks above, just as the genuine columns carry the architrave. The metope slabs support nothing, but are merely a filling in, having their broad surfaces outward and their edges fitting against the sides of the triglyph pieces. The metope slabs were generally, though not invariably, used as surfaces for sculpture or carved decoration, as indicated on Fig. 54. Above this portion comes the cornice, which marks and gives expression to the overhanging eaves of the roof, and forms, so to speak, the eyebrows of the building. The underside of the projecting portion of the cornice is sloped, and is broken up by a series of flat slab-like forms (sketched in perspective in Fig. 49) called *mutules*, the surfaces of which are again broken up by a series of small circular flat-ended knobs, called the *guttæ*. All these main features are duplicated as we rise from the lower to the upper portion of the design. For each column there are two triglyphs, one centrally over the column and one over the interspace (except in regard to the angle columns, of which we will speak presently); for each triglyph, similarly, there are two mutules, one over the triglyph and one over the interspace. At the sides of the building the cornice is horizontal: at the ends, as shown in Fig. 48, the upper member assumes a raking line, following and expressing the sloping line of the roof.

This is the form in which the Doric style appears in its perfection in the Periclean era of Greece, about four centuries and a half B.C. Whence where these details originally derived?

It has been commonly held that a great portion, if not all of the Greek Doric details, were derived from an original pre-historic wooden form of construction, the reminiscences of which were laid hold of and worked into a masonic form by the later Greeks. In regard to the columns, however, this seems improbable. In the first place, stone columns which are obviously the rough unfinished idea of the Greek column are found in Egypt, belonging to a period long previous; such forms as are shown in Figs. 42 and 43. Secondly, the earlier Greek Doric columns, found at Pæstum and Corinth, and which have all the details of the finished Doric, only with less refined treatment, are thicker and more massive in proportion than the finished Doric; whereas if the original form had been a wooden one, the probability is that the earlier stone columns, closer in time to the wooden original, would have been the thinner in proportion, and the thicker masonic proportions would have been gradually adopted later on. There have indeed been found on vases of an early period such representations of columns as those shown in Fig. 41, which have been taken to give a colour to the theory of a wooden origin; but it is much more probable that these were only a conventional decorative treatment of the column form, arbitrarily adopted by the vase-painter. The architectural lesson to be learned from the Doric column as it stands, lies in its severely abstract treatment as a feature for supporting weight in an expressive manner. If we compare it with one or two of the typical Egyptian forms, shown in Figures 44 and 45, we shall see that the latter exhibit a certain degree of imitative character; 44 preserves the idea of a bundle of stems and buds bound together; 45, besides being clumsy in proportion, retains a very decisive flower form in its capital, and the turn-in of the column at the foot is also a feature quite at variance with abstract architectural feeling and with the expression of monumental solidity; it is a feature much more suited to a miniature object than to a column on a great scale, as this is. The Greek Doric column imitates nothing; it is a creation in itself. The lines formed by the flutings give it verticality of expression and

what may be called sinew; there is a quasi-muscular expression about it, quite distinct from the cushiony flabby look of a big round column with no surface treatment, as frequently used by the Romans. The small cut just below the necking gives the first hint to the eye of stopping the upward lines of the flutings; the series of striations round the necking completes this stop; the *echinus* moulding (as it is called) below the abacus carries the eye out to the angle of the abacus; this moulding, in the best Greek work, is a very fine hyperbola curve, admirably adapted to give an expression of strength and support to the abacus, at the same time affording occasion for a very delicate play of light on the delicately modelled surface. The section of the echinus and necking, larger scale, is given at A, Figure 76. The only defect in the capital is the want of some filling up of the projecting angles of the abacus, which in an angle view (see Fig. 49) seems to stand out rather awkwardly from the top of the echinus. Otherwise, the Doric column and capital may be said to be the most perfect and intellectually finished architectural feature in existence, made as it was in fine marble which allowed of the greatest perfection of line and finish; and to appreciate its delicacy of treatment we have only to compare it with the "Roman Doric" capital opposite (Fig. 50), with its commonplace half-round echinus and big projecting necking moulding; and compare the Greek section, 76 A, just referred to, with the corresponding Roman section 76 C; and the difference between artistic and inartistic work is prominently brought out.

In regard to the Greek entablature, however, the wooden origin seems little doubtful. We have not all the links in the transformation, but we have enough to give an idea of its progress. The form of rock-cut temple that has been found in Asia Minor, as shown in Fig. 40, is obviously a piece of carpentry imitated in stone, and if the upper portion of the side view of that be compared with the triglyph arrangement of the Doric frieze, it will be seen how almost inevitable is the conclusion that the triglyphs are the reminiscence of the ends of beams which formed a portion of the original timber construction. It even seems as if the triglyph ornament itself, the grooving, had rather a wood-chopping stamp left on it; that it might have been originally such a treatment of the ends of beams as is indicated in Fig. 55. The grooving, like the fluting of the columns, serves to emphasise the vertical function of this part of the masonry; but I confess the triglyph never seems to me to be a feature quite so intellectually worked out as other portions of the order. The feeling for balance of opposing lines, shown in the vertical and cross lines of the column, is again shown here, however, in the little bracket which is placed beneath the architrave fillet, below each triglyph—something for the vertical lines of the triglyph to repose upon, lest they should seem too heavy for the fillet itself. The mutules have, like the triglyphs, the appearance of being a reminiscence of wooden construction; Vitruvius speaks of them positively as representing the ends of the principal rafters, just as, he says, "in the Ionic order the *dentils* imitate the projection of the common rafters." (The dentils are the smaller square-shaped projections, an example of which is seen in the Greek Corinthian cornice shown in Fig. 53.) "Hence," he goes on to say, "the Greeks never placed dentils below the mutules, because the feet of common rafters cannot be below those of principal rafters;" the "common rafters" being the upper smaller ones which are supported by the principal rafters. This shows how Vitruvius saw the wooden origin of the classic entablature, but this is no proof that the Greeks saw it in the same light: at all events the builders of the Doric temples of the great period had forgotten or ignored this "rafter" origin of the mutule, for, as will be seen on Fig. 48, the slope of the underside of the mutule is different from the slope of the roof line, which would necessarily be that of the rafters. Its origin was probably a wooden one originally, but the Periclean Greeks had apparently come to regard the mutule simply as a way of breaking up the horizontal line of the main projection of the cornice, and its shadow line also. The reason suggested by Mr. Garbett for making the underside of the cornice and mutules on a raking line is that the cornice being viewed from below, its lines would have appeared much too flat and spread out too much, especially at the angles, if kept horizontal, as shown on Fig. 49A, which represents the angle of the cornice as it would appear if the underside of it were horizontal; it would also lose some of its decisive shadow effect. It appears therefore, all things considered, that our Doric cornice is composed upon the main lines of an ancient wooden construction, but so far translated into stone forms that its origin has been nearly lost sight of by the designers; but for all that it never attained

quite the same perfection of intellectual expression as the column and capital, which were from the first, masonic forms; and it may be a question whether the Doric cornice and frieze could not be improved upon, although long association has made all the parts appear, to us, almost essential the one to the other.

In one respect, however, the Greeks retained a purely logical method in this portion of the work, viz., in the treatment of the triglyph at the angles of the building, already referred to in passing. Over all the columns except the angle ones the triglyph is placed centrally; but to have placed it so over the angle columns would have involved taking the triglyph away from the angle. This would have involved either a false or an actually weak construction, as the triglyph is the solid supporting portion of the frieze, and at the angle this solidity is requisite especially. Accordingly at the angle the triglyph, as shown in Fig. 48, is not over the centre of the column; but in order to preserve the regularity of spacing here, and to keep the metopes, which are generally used for a series of square bas-reliefs, all of the same size and shape, instead of having an oblong space near the triglyph, the angle column and the one next it are placed closer than the others;* or in other words, the "intercolumniation" (the space between the columns) is narrower next the angles. This narrower spacing of the columns at this point does not offend the eye, on the contrary it rather improves the architectural stability of the whole structure by giving it an appearance of greater solidity at the angles, whereas the interference with the regularity of spacing in the frieze and cornice would have been very unpleasantly apparent. The Romans quite overlooked this, and keeping the columns equally spaced, placed the last triglyph over the centre of the last column (Fig. 50), thus not only weakening the angle of the frieze, but taking away from the triglyph all its meaning as a supporting pier, and making it a mere surface ornament of no meaning; thus neglecting a real piece of architectural logic for the sake of an inferior and false logic. In the Greek building the triglyph was so entirely the constructive portion of the frieze that the metope slab might have been quite loose, or been capable of turning round and opening on a pivot, as is shown in Fig. 59, without affecting the stability of the cornice above it in the least; and Mr. Tadema, whose paintings show such a complete insight into the spirit of Greek as well as of Roman architecture and design, has actually shown it so in one of his paintings.

* This will be seen in reference to the plan of a Greek temple, Fig. 27 in Lecture I.

In designing the details of their style the Greeks, as is evident both from a study of the remains of their works and from what we learn from Vitruvius, proportioned every detail with a definite relation to the scale of the whole, the diameter of the column being apparently the principal *modulus* for determining the scale of the other details. Vitruvius gives a multiplicity of rules for thus proportioning the details, which, though they may not, and in some special cases obviously do not, represent accurately the Greek method of working, are nevertheless in all probability a correct representation of the general principle on which Greek buildings, as well as the Roman ones in imitation of them, were set out. The height of the column bore a certain relation to its diameter; the height of the whole entablature a similar kind of relation to the height of the column; in the Parthenon, the greatest and most complete example of Doric architecture, the width of the abacus of the end columns is 1-15th of the width of the upper step on which the columns rest: and so on through every detail. This accurate proportioning on a fixed principle is one of the most remarkable characteristics of classic architecture. Thus the whole column and entablature in each style becomes a highly artificial organised structure, in which every portion is designed with reference to the rest; and it is this mutual relation and correspondence of the parts which has led to the combined design of column and entablature being regarded and spoken of as an "Order," *i.e.*, as something designed according to a fixed and recognised order *(ordo)* or relation of parts.* It is this severe logical relation between the several parts which renders Greek architecture (and in a much lesser degree Roman architecture) such an admirable study for the training of the eye in architectural design, even where there may be no purpose of actually using or applying its forms in modern buildings.

But the refinements of the Greek Doric style did not stop here. Certain passages in Vitruvius give a hint about a system of correct-

* In delivering this lecture I referred to "The Orders" without explanation; I have since discovered that some of my audience did not understand what was meant by an "Order."

ing the lines of the building for optical illusions, the true meaning of which, however, was not understood until Mr. Penrose undertook his remarkable investigation of the remains of the Parthenon, and discovered and laid down accurately the lines of curvature employed in what were theoretically the straight lines of the building. It had long been known that the bounding lines of the columns are curved; the curve is sufficient to be seen when looked for, being a departure of about half an inch from the straight line in a height of about twenty-nine feet. Some of the old Doric examples, such as that at Corinth, have this curve, which is called the *entasis* of the column, much more developed, and apparently intended to produce a visible effect in the design; in the later Doric, however, it is refined down into a kind of concealed curve, if we may say so, not intended to catch the eye, but intended to compensate for a certain tendency which a straight-lined column has to appear slightly hollow in line. Why there should be this tendency to a hollow appearance in such an object it is not easy to say; it certainly does occur, and will be felt (rather than perceived) by all accurate observers. What is still more remarkable is that this long flat curve, which has its apex about one-third up the shaft of the column, Mr. Penrose discovered to be a very flat hyperbola curve, the line falling in with this curve too precisely to leave, in his mind, any doubt of the intention. This fact, which is quite in keeping with what we know otherwise of the essentially mathematical turn of the Greek mind, may serve to give some idea of what a delicate and complicated affair architectural design was with the Greeks, and how different a kind of problem from that of architectural design as it is understood nowadays. Vitruvius refers also to the necessity of making the line of the basement or *podium* curved; "if it be set out level," he says, "it will have the appearance of being sunk in the centre:" and in accordance with this it is found that the lines of the steps in the Parthenon have an upward curve of about four inches in the end steps (the top one of which is 100 feet long) and about the same in the side ones. The end cornice is also curved upward to about the same extent; the reason of this is very obvious, for the contrast with the raking lines of the pediment cornice leaving this straight line would inevitably be to make the straight line appear to sink; all lines of opposing directions or curvature tend to exaggerate their opposing directions by contrast,* and the critical intellect of the Greek, satisfied with nothing short of perfection, fought against this distorting effect of vision at every turn. The angle column, which was liable to be seen against the light at an angle view, instead of against a shadowed background, was made slightly thicker than the others, in order to allow for the fact, with which all painters are familiar, that an object dark against light is seen rather smaller than the same object light against dark; the light space always appearing to encroach somewhat on the dark one. This does not bring us to the end of the Greek refinements, for in addition to these curves for optical correction, the whole body of columns were set leaning slightly inwards, and the face line of the entablature also, by a very slight deviation from the perpendicular. One possible reason for this slightly pyramidal arrangement of the building may be illustrated by Fig. 58, which represents the section of the colonnade. As the column diminishes upwards (the diminution being purposely exaggerated in the figure), it will be seen that the space between the colonnade and the wall would appear wider at the top (H) than at the bottom (K) which, to a spectator standing within the colonnade, would make it appear as if the columns leaned away from the building. This bad effect may be actually seen in many modern colonnaded buildings in imitation of the Greek style. It seems probable, however, that there was the intention, in addition to this, to give the building externally a slightly pyramidal line to counteract an optical illusion by which a building of perfectly vertical lines appears to lean outwards slightly; for the line of the entablature is also set slightly back in the same manner. It is worth note that Vitruvius advises the precisely opposite treatment of the entablature, viz.: to let its lines slope slightly outwards towards the top, for the reason that as the entablature is seen foreshortened by a spectator looking up to it, some of its apparent height, and therefore of its correct apparent proportion with the height of the columns, would be lost by the spectator standing on the

* This may be proved very easily to the eye as follows:—Draw two perfectly straight and parallel lines in ink on white paper, say an inch apart and eight inches long, and draw two segments of circles one on either side of the parallel lines, so that each curve turns its convex to and nearly touches one of the straight lines; those two lines will then appear to converge slightly towards the top and bottom Draw a similar diagram reversing the segments of circles, so that the concave of each of them is towards the parallel lines and the latter will then appear to be rather wider from each other towards each end, or hollow in the intermediate part.

ground level. This is a strictly logical reason from the point of view here assumed by Vitruvius; but as it is clear that the practice of the Greeks, at all events in their greatest and most perfect building, was opposed to it: this is one of other reasons for supposing that Vitruvius, valuable as his hints are for the understanding of the Greek system of architecture, was not entirely master of their practice.

The diagram, Fig. 57, gives, as a kind of memorandum, a greatly exaggerated representation of the arrangement of the curves of the steps and cornice of a Greek building, and the leaning inward of the angle columns,* showing also that the capitals were set so as to be parallel with the line of the architrave, not at right angles with the line of the column. Of course no such distorted effect would be in the least visible to the eye; it is shown visibly here to render the facts apparent, but is in reality only ascertainable by measurement; the object being not to distort the building to the eye, but to conceal a certain apparent distortion which the eye itself might produce.

The main consideration has here been given to the Doric style, because of all the styles of classical architecture it is the most refined, complete, and logical. The two other styles of Greek architecture were the Ionic and the Corinthian. Each of these also consists, in its main features, of a column and entablature on the same principle as the Doric, but with different proportions and details. There is not space here to go through these styles in the same detail as the Doric, but some facts in regard to them may serve to further illustrate our subject. It should be remarked here, and it is an important point as illustrating the manner in which architecture was practised by the Greeks, that these two styles are not progressive developments from the Doric, as in the various styles of Gothic architecture. In the latter, as we shall see when we come to consider them, the different styles succeeded each other almost insensibly by a process of natural development, arising in great measure from a struggle with constructional and geometric difficulties. But the three Greek styles, as may be seen especially in comparing the most prominent feature of each, the capital, have no such relation of development. The Doric capital (Fig. 48) contains not a suggestion from which to develop the Ionic (Fig. 51), which was used simultaneously with it in adjacent buildings; nor does the Ionic bear any family resemblance to the Corinthian (Fig. 53), which was slightly later in its use. The three appear to have been deliberately selected from different sources, and separately elaborated and refined. This fact is a very remarkable testimony (often overlooked) to the intellectual independence of perception of the Greeks; for there is no other instance known to us in the history of architecture prior to the Renaissance (when the whole process of architecture was altered), of such a deliberate and nearly simultaneous selection of architectural types at the mere will and taste of the selecters. In Gothic architecture, the "Early English" capital was an insensible and apparently almost inevitable development from the Romanesque capital, and the "Decorated" capital in like manner from the Early English; the process is so gradual and apparently unpremeditated that the line of demarcation between the one and the other style cannot be precisely selected. The Greeks alone seem to have had that clear critical power which raised them above the influence of mere circumstances, and enabled them deliberately to choose the good and reject the bad, and to fashion their architecture according to their reason and not in obedience to a blind process of development; and there can be no doubt that this is the highest intellectual standpoint of the architectural designer, although during the fervour of the Gothic revival in this century it was the fashion to think otherwise. The Ionic style, as its name indeed implies, probably had its origin in Asia Minor, where rock-cut proto-Ionic columns have been found, just as rock-cut proto-Doric columns are found in Egypt. The most noteworthy point in regard to the Ionic capital is that in these early forms which were its origin, it is usually if not always found on ranges of columns which are bounded at each end by projecting pilasters or masses of wall, so that the capital was only really seen in front face (as drawn in Fig. 51), and was not seen as an angle capital. A glance at it will indicate how completely it expresses and suits this position; it is a capital for a front view only, the side view of the capital showing only a big pillow-like roll. The Attic Greeks, with rather less than their usual critical perception, did, however, use this order, from time to time, in such a position that it became an angle column, and they then met the difficulty by giving the angle capital a double face, and setting the angle volute turned outwards from

* The leaning inward of the entablature is not shown in the diagram.

each face and at an angle of 45° with the main lines of the building, thus making the angle volute do double duty, for each face of the capital.* This was not a very happy expedient, and it may be taken as an example of the danger, even in the best hands, of removing a feature from the position it was originally designed for, and using it in one for which it is not suited. In the Ionic or Corinthian styles the triglyphs had no existence, and the frieze became a continuous band, often used, especially in the Corinthian style, as the field either for a continuous decorative design, or for a series of figures in bas-relief telling some story of gods or heroes. In this point alone these styles seem to have taken a hint from the Doric, in which, as we have observed, the sculptured portion of the frieze, the metope slab, was the portion not doing any constructive work, and therefore fitted especially to be used as a space for decorative treatment. Where the triglyph blocks are no longer used, the whole wall of the frieze of course becomes a portion of the construction, there being nothing else to carry the cornice; but the Greek metope interspace having been formerly selected as an appropriate field for sculpture (long before the Periclean age), the frieze seems thence to have succeeded to that office (not quite so logically) even after it had ceased to be an alternation of supports and spaces, and had become a solid wall, to outward appearance at least; for in reality the blocks actually sculptured were usually comparatively thin facing blocks; still they form architecturally the main wall surface. But this surface decoration was applied only to the frieze; the Greeks never weakened the great constructive feature, the architrave, by carving it, unless by the addition of a narrow band of ornament in such a way as to emphasise its horizontal lines. We may observe in Figure 53, the entablature of the Choragic monument, the first step towards modifying the treatment of the architrave, and notice what a strictly constructive treatment it is. Instead of the architrave having one unbroken face, as in the Doric style or in the Ionic example given in Fig. 51, it is divided into three faces very slightly projecting one beyond the other, so as to break up the architrave into three horizontal faces, each projection giving, in a bright climate, a thin dark line of shadow under it. There can be no doubt that the main object of this was to give a somewhat lighter appearance to the architrave, to harmonise with the slighter proportions of the columns used in the Doric and Corinthian order, while still retaining its constructive depth in one block. The proportions of the columns of the three orders are seen comparatively in Figs. 54, 59, 60; and it will be observed that the bare heavy block of the Doric cornice* would appear very heavy over the lighter column of the Corinthian order. But this treatment of the architrave, it will be seen, is still a severe and logical treatment; the horizontal lines emphasise its horizontality, just as the fluting lines emphasise the verticality of the column. In Fig. 52, an Ionic architrave, a line of repeating ornament is placed as a kind of miniature cornice to the architrave, giving it a richer effect, but still in subordination to the true expression of the architrave, as a solid block supporting the rest of the entablature. Another point in Greek design which may here be illustrated is the distinctive treatment given to the pilaster against the wall which takes the end of a cross-lintel the opposite end of which rests on a column. Such a projection or half column against the wall, and forming constructively part of it, is called in classic architecture an *anta;* the feature playing the same part in Gothic archirecture, as in the wall-pier from which the first arch of an arcade springs, is called a *respond*. In Gothic architecture the respond is usually treated in just the same way as the complete pier; it is a half-pier against the wall; but this would not have satisfied the nicer critical sense of the Greeks. The *anta* was a portion of the wall projected to answer to the column which took the other end of the lintel; it was to have a capital to give it expression, but it was to be treated in a manner perfectly distinct from the column. F, Fig. 52, is a square anta capital from the Erechtheion, which responds to an Ionic capital of the usual form: it will be seen at once how distinctive is the treatment. The base is also varied, E being the base of the anta, D the base of the corresponding column. In the case of the bases there is not such a difference in type; the object seems to have been partly to avoid monotony by a variation of the mouldings. In the Doric style the distinction between the column and anta was even

* A modern imitation of this may be seen in the angle columns of the British Museum colonnade.

* The circles seen on the Doric architrave in No. 54 represent shields hung on the architrave, probably as offerings or memorials of some kind, which is known to have been done; but these are not portions of the architectural decoration.

more decisively marked; at the two ends of the Parthenon the longitudinal walls of the *cella* project a little way past the cross walls at the end (see H, H, on plan, Fig. 27, lecture I.), each facing a column of the inner colonnade; and these projections are treated simply as pieces of wall with a moulded capping to them, sufficient to emphasise them as being *en rapport* with the column, but in no way imitating it.

The Corinthian style as best known is in reality rather a Roman variation than a pure Greek style; the great Greek example, the remains of the temple of Jupiter Olympius, having been built under the Roman dominion and probably under Roman architectural influence, though perhaps executed by Greek hands. The Greeks had gone so far in that direction, however, as to have produced the exquisite capital of the Choragic Monument (Fig. 53), the upper portion of which is beyond all praise as a most beautiful piece of conventional ornament; in the lower portion there is perhaps rather a want of unity between the richly carved portion of the leafage and the plain leaves surrounding it at the base, and which seem hardly powerful enough, so to speak, for the rest. There can be little doubt that the original suggestion of the Corinthian capital was from the Egyptian capital, though Fergusson has given reasons for thinking that suggestions from Asia Minor were contributory to it also. If we compare it, however, with the Egyptian form shown in Fig. 46, we shall see that there is the same idea at the root of both; a base of successive leaves, with longer forms rising from behind them. The Egyptian form here given is a circular capital, that of the Greek has a square abacus; and the flat foliage forms of the Egyptian, produced rather by incising than carving, are a natural method of treatment for granite, in which such more luxuriant forms as those of the Greek capital could not have been well executed. But if we were to take the Greek capital of the Temple of the Winds,* which is also a circular capital with comparatively flat leaves, only of a different type, its affinity with the Egyptian capital would be at once apparent; and the step from this to the Corinthian capital is not a very long one, except in regard to the scrolls or volutes at the angles; this was an essentially Greek feature, to support the angle of the abacus, and of its previous history we know little, but it has played a great part in architecture ever since its creation, as we shall see in a future lecture.

* A drawing of this was shown at the lecture.

In speaking of Greek architecture, we are under the necessity of passing over the question of its roofing rather dubiously, for of the timber portions of the roofs which undoubtedly once existed there are no remains, and we are left pretty nearly to conjecture. But as far as the effect of the roofing on the architectural design is concerned, there can be no manner of doubt that the roofs were strictly on the beam principle, and that all the architectural development of the substructure is therefore perfectly in keeping with its office, as being designed to resist vertical pressure only, not outward thrust. Fergusson has left on record a carefully worked out theory as to the manner of lighting and roofing a Greek temple, which has great appearance of probability, but it is probability only, though its accomplished author was prepared to consider it as certainty. We may fully accept, however, the negative certainty that, however the Greek temples were treated, they were *not*, as once universally taught, unroofed and open to the air. An architecture with no interior is no architecture at all.

It will be observed that in Figs. 59 and 60, (which for convenience sake are reduced from some old but tolerably correct engravings), the entablature portion is shown with a boundary line on each side, a mere slice of entablature over the column and central with it, instead of being shown as a continuous construction, as in Fig. 54, which was made for the present purpose. This method of showing the entablature is very characteristic of the manner in which the Order came to be regarded by the Romans, and by the Renaissance architects who worked on Roman lines. The Romans, copying the Greek order, but beginning to employ the arch freely in their buildings, could not discern that the arch, which was one mode of covering over the space between the points of support, stood naturally and properly in the place of the architrave, as the portion supporting the superstructure. To their ideas, regulated by those conventional rules which Vitruvius has summarised, it evidently seemed that a column was incomplete without an entablature; and accordingly, instead of springing the arch from the column, they inserted a square slice of the proper entablature over the column, and sprung the arch from that, as in Fig. 68. This treatment, which has been largely imitated in modern architecture since the Renaissance, is perhaps

the most absurd and illogical blunder ever made in architecture; but blunders die hard when they have once become fashionable, and this one is still going on. Another Roman falsity in architecture was that, when they did use an arched form with only a capital or "impost" moulding,* they planted a columnar order in front of it, as in Fig. 67, with an architrave which makes believe to be carried by the column, but is really carried by the arch. The same thing is shown on an extended scale in the portion of the Colosseum design given in Fig. 69. The Colosseum is in reality a completely arched construction, but as it was a show building it had to be made "architectural" by planting a series of "orders" on the outside of it. A remarkable and very instructive fact is that when the Romans built purely utilitarian works on the same arched construction, in which it was not thought worth while to put ornamental pilasters and entablatures on, they really produced grand and impressive as well as perfectly truthful structures, as in their aqueducts, a sketch of a portion of one of which (that of Segovia) is shown in Fig. 70. Here it will be seen is a perfectly genuine and honest piece of building, pretending to be nothing but what it is, and really impressive from its scale and massive construction, though in the minds of its builders it was a purely engineering work. We find an equally instructive parallel to this in the present day, where an engineering work such as London-bridge, which is simply grand and massive, without pretence at architectural treatment, is a really impressive and (as the late Mr. Street called it) "a sublime bridge;" while Blackfriars-bridge, on which the engineers have clapped a quantity of vulgar and meaningless architectural (?) detail, is merely a ridiculous sham.

Returning to the classic order, which we have quitted for a moment, I have ranged in a row at the top of Plate VI. the respectable family of "the Orders" (Figs. 61 to 65) as practised by the Roman architects and classified by Vitruvius. Whereas the Greeks had three styles or orders, the Romans made up five, the distinctive names of which are given above them in the diagram. Precisely how or why these "Five Orders" came into being we cannot now determine; but they have, under their tutelary patron Vitruvius, exercised a great influence on subsequent architecture, and have been during no inconsiderable period of architectural history regarded as the Alpha and Omega of architectural design. But it would appear as if Vitruvius had really played somewhat the same part in regard to Greek architecture which Rickman, in a lesser way, played at the commencement of the Gothic revival in regard to Gothic architecture. Rickman classified Gothic architecture into Styles or Periods; Vitruvius classified Greek architecture, or what he supposed to be such, into Orders. The Tuscan Order, which was very plain and massive and entirely unornamental, was probably of Italian origin. The Doric of Vitruvius, as we have already suggested, was only a kind of travesty of the genuine Doric. The Ionic more resembled the Greek form, except in the liberties the Romans took with the capital. The Composite was a deliberate invention of the Romans, formed by combining the volute of the Ionic capital (in its angular position) with the foliage of the Corinthian. The result can hardly be called happy; it is only a Corinthian capital with an abnormally overgrown volute. The Roman Corinthian Order was the best achievement in this respect of the Roman architects; the capital is very finely designed, or it has retained more of pure Greek taste than any other of their capitals; the frieze and entablature, with their frequently highly-elaborated and sumptuous decoration, produce a *tout ensemble* which, though it is not of the most refined kind, has a power and richness of decorative effect which cannot be denied. The mischief to architecture which has been worked by these Orders is partly due to untoward circumstances. At the revival of classical learning in the Renaissance period, the work of Vitruvius* was the one available literary guide, in the revived Latin literature, to the treatment of classic forms of architecture. His rules for the treatment of the Orders became a kind of architectural bible, the final authority from which there was no appeal. His rules thus became impressed on the modern architectural mind as of the first importance, and the result of this exaggerated worship of the Orders has no doubt been very prejudicial in some respects to modern architecture of the classical school, tending to render it a study of conventional scholastic rules instead of a free art. But in admitting this, it must be added that it is a great mistake to regard Vitruvius as a person to be spoken of

* "Impost" is the point from which an arch springs.

* Vitruvius was a Roman architect who apparently, from his own account, had little actual practice, but was very well acquainted with his profession, and who completed his book probably somewhere about 25 B.C.

slightingly or contemptuously. His book contains, besides his no doubt conventional rules for architectural designing (which were probably such as were generally accepted by the Romans in his day), evidence of very wide and complete practical knowledge; his idea of the dignity and of the *morale* of his profession is the very highest; he must have been an essentially noble-minded and upright man, from the internal evidence of his writings; and he succeeded in producing a treatise on a professional and technical subject which has lived for nearly two thousand years, has been translated into the language of every civilised country, and which even at the present moment no architectural library can afford to be without. It is not given to many men to accomplish that; and the young modern architect who sneers at Vitruvius is rather showing his own ignorance than discrediting the name of a man who, whatever his mistakes (which were partly at least those of his age rather than of himself individually), was an honour to his profession.

I have added to Plate VI. of the diagrams a few typical examples of Greek and Roman ornament (Figs. 71 to 75). The fuller consideration of this portion of the subject will be gone into in the fourth of these lectures; but one or two of the examples here given may point a lesson in regard to the distinction between abstract and merely imitative ornament. Fig. 74, for instance, is an example of Roman ornament in which there is a pretence of binding together the several rolls of the moulding by a fillet wound spirally round them. No Greek artist would have done anything so commonplace and prosaic as that. In the Greek "egg-and-tongue" ornament, again (Fig. 72), it will be seen that the forms are totally abstract; they imitate nothing; they are merely the effective alternation of a round and a pointed form. The Roman, in his version of it (Fig. 75), changes the pointed form into a direct imitation of an arrow-head, thus destroying its abstract character. The carved ornament from the Erechtheion (Fig. 71) is one of the most perfect specimens in existence of an ornament based upon nature and upon the principle of growth from a central point, but conventionalised into the most graceful architectural lines; a hint from nature, transmuted by the hand of the artist into architectural form.

In conclusion, the general lesson which we learn from the study of the Greek treatment of trabeated construction is that architecture in its intellectual form is not a matter of mere picturesquely sketched effects, but an art in which no study and refinement should be spared in order to produce the most logical expression of the construction of the building, and the most carefully designed and thought-out treatment of every portion, both in itself and in relation to the whole. It is impossible to come away from any prolonged study of Greek work without a feeling that all other architecture, however poetic and picturesque in general effect, is, by comparison, unfinished and unsatisfactory in its working out; a feeling which has been well expressed by Clough in some lines from his "Dipsychus," with which I will conclude, not as expressing the whole architectural truth, but as a very good expression of one side of it, that which we have been considering this evening:—

> "'Tis not, these centuries four, for nought
> Our European world of thought
> Hath made familiar to its home
> The classic mind of Greece and Rome;
> In all new work that would look forth
> To more than antiquarian worth,
> Palladio's pediments and bases,*
> Or something such, will find their places;
> Maturer optics don't delight
> In childish dim religious light,
> In evanescent vague effects
> That shirk, not face, one's intellects;
> They love not fancies just betrayed,
> And artful tricks of light and shade,
> But pure form nakedly displayed,
> And all things absolutely made."

* If he had said "the Grecian pediments and bases" it would have been more to the purpose.

Miscellaneous.

BRAZILIAN RAILWAYS IN 1886.

According to the *Bulletin du Ministère des Travaux Public*, Brazil had a told length of railway line, open for traffic, in course of construction, and projected on the 31st December, 1886, amounting to 8,046 miles—distributed as follows:—4,763 miles open for traffic, 1,012 in course of construction, and 2,271 miles of projected railway line. Of the 4,763 miles actually open for traffic, 841 miles were broad guage lines. The total length of line belonging to the State amounts to 1,144 miles, 204 miles belong to the various provinces, and 341 miles to Brazilian and English companies. There is only one French railway company in Brazil, the *Compagnie Générale des Chemins de Fer Brésiliens de Paris*, which works the line from Paranagua to Curytiba crossing the

Sierra de Cubatao, 3,000 feet above the level of the sea. Of the 3,415 miles of railway line owned by the various companies, 1,444 miles belong to companies having the interest guaranteed by the State, 929 miles to companies whose interest is guaranteed by the various provinces, 997 miles to companies having no guaranteed interest, and 45 miles to the suburban line of Rio de Janeiro. The first railway in Brazil, the Mana line, from the shores of the Bay of Rio to the foot of the Orgues chain of mountains, was opened on the 30th April, 1854.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock: —

JANUARY 18.—"Methods of Taking the Ballot." Three papers by JOHN LEIGHTON, JAMES WITHERS, and JOHN IMRAY. The ATTORNEY-GENERAL, M.P., will preside.

JANUARY 25.—"Theatres and Fireproof Construction." By WALTER EMDEN.

FEBRUARY 1.—"The Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS.

FEBRUARY 8.—"The Technical Education Bill." By SWIRE SMITH. PROF. SIR HENRY E. ROSCOE, M.P., will preside.

Dates to be hereafter announced:—

"Technical Instruction in Agriculture." By PROF. JOHN WRIGHTSON.

"Machine Tools for Boot and Shoe Manufacture." By JOHN W. URQUHART.

"Framework Knitting." By W. T. ROWLETT.

"Locks and Safes." By SAMUEL CHATWOOD.

"Telescopes for Stellar Photography." By SIR HOWARD GRUBB, F.R.S.

"The Measurement of Electrical Currents." By PROF. GEORGE FORBES, F.R.S.

"The Continuation of Elementary Education." By W. LANT CARPENTER, B.A., B.Sc.

"Type-writers and Type-writing." By JOHN HARRISON.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 31.—"The Monumental Use of Bronze." By J. STARKIE GARDNER, F.G.S.

FEBRUARY 14.—"Principles of Design, as applied to Bookbinding." By HENRY B. WHEATLEY.

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE.

APRIL 24.—

MAY 8.—"What style of Architecture should we follow?" By WILLIAM SIMPSON.

MAY 29.—"Persian Textiles." By CECIL SMITH.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 17.—"The Colonies and Dependencies of Foreign Nations." By A. J. R. TRENDELL, C.M.G.

FEBRUARY 7.—"British Columbia." By HENRY COPPINGER BEETON, Agent-General for British Columbia.

MARCH 6.—"South African Gold Fields." By W. H. PENNING, F.G.S.

MARCH 27.—

APRIL 17.—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

JANUARY 27.—"The Public Health in India." By MR. JUSTICE CUNNINGHAM, of the High Court of Judicature, Calcutta. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

FEBRUARY 10.—"Facts regarding the Religions of India, and their influences on the moral progress of the people." By SIR WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D.

FEBRUARY 24.—

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras.

MAY 4.—

The above dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE I.—JANUARY 30.—Yeast an organised cell.—Considered as a plant.—Why classed among plants.—How to be studied.—Phenomena connected with the growth of the cell.—Fermentation.—Kind of fermentation related to character and quality of yeast.—Conditions necessary to healthy growth.—Classification of the pure yeast cell among plants.—Its relation to the higher orders of plants.—Resemblances and differences.—How these are accounted for.—Its assimilating powers compared with those of the higher plants.—Yeast classed among the lower forms of vegetal life.—A fungus.—Its position among fungi.—A parasite or saphrophyte.—The characteristic features of its class.—Its relation to the other members of its class higher and lower in the scale.—Hyphal, sprouting and fission fungi.—Fungi capable of inciting fermentation and putrefaction.—Fungi capable of inciting alcoholic fermentation.—The yeast species defined.—Phylogeny.

LECTURE II.—FEBRUARY 6.—Mode of reproduction of yeast.—By sprouting.—By endogenous division.—The latter term defined.—Ascospores.—Conditions necessary to their formation.—Conditions of nutriment, of temperature, and of time.—The method of production explained.—Classification of saccharomyces according to their power of producing ascospores.—Those which form them.--Those which do not.—Critical examination of the various species from this point of view.—Saccharomyces and torulæ.—Analytical table of ascospore formation among saccharomyces.—Its practical significance.—Pure yeast secured and maintained by reference to it.—Impossibility of identifying species of saccharomyces except by ascospores.—*S. Cerevisiæ* capable of assuming typical forms of other species and conversely.—Top and bottom yeast.—Their resemblances and differences.—Character of beer determined by species of saccharomyces employed.—The essential differences explained.—Conditions necessary to healthy multiplication by sprouting.—Primary considerations affecting the question.—Fungal cellulose.—Protoplasm.

LECTURE III.—FEBRUARY 13.—The internal structure of the yeast cell.—Vacudes.—Granules.—Nuclei.—Nucleoli.—Gelatinous membrane.—Fat.—Composition of the cell.—Organic constituents.—Inorganic constituents.—Wort as a saprophytic food adapted to their supply.—Composition of wort.—Influence of malt upon composition and uniformity of wort.—The production of sterile wort.—Is it a necessity?—Is it possible upon the large scale?—Sterile wort as a medium for pure yeast culture.—The production of yeast from a single cell.—The test of purity.—Mode of preserving pure cultures.—The life of a yeast cell.—The transport of pure cultures.

LECTURE IV.—FEBRUARY 20.—Pure yeast in the brewery.—Apparatus employed in its production upon the large scale.—Method of manipulation.—Results achieved.—Is the method available in high fermentations?—What advantages might it produce?—The products resulting from yeast growth.—Fermentation.—Historical retrospect.—The various theories.—To what extent are they reconcilable?—What practical advantages have been derived by their enunciation?

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R A., on Thursday evenings, February 2nd, 9th, and 16th.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 2...Chemical Industry (London Section), Burlington-house, W., 8 p.m. Dr. J. J. Hood and Mr. A. Gordon Salamon, "A new method of removing Sulphur Compounds from Coal Gas."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Prof. Duns, "Natural Selection."

London Institution, Finsbury-circus, E.C., 5 p.m. Sir Robert S. Ball, "Visible Stars."

TUESDAY, JAN. 3...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Sir Robert S. Ball, "Astromony." (Lecture III.) The Great Planets.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m. Annual Meeting.

WEDNESDAY, JAN. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Juvenile Lecture.) Mr. W. H. Preece, "The Applications of Electricity to Lighting and Working." (Lecture I.)

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Mr. A. Fairlie Bruce "Salmon Passes."

THURSDAY, JAN. 5...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture IV.)

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Sir Robert S. Ball, "Astronomy." (Lecture V.) The Comet.

FRIDAY, JAN. 6...Geologists' Association, University College, W.C., 8 p m. Mr. T. A. Readwin, "The Occurrence of Gold in North Wales."

SATURDAY, JAN. 7...Royal Institution, Albermarle-street, W., 3 p.m. (Juvenile Lectures.) Sir Robert S. Ball, "Astronomy." (Lecture VI.) The Stars.

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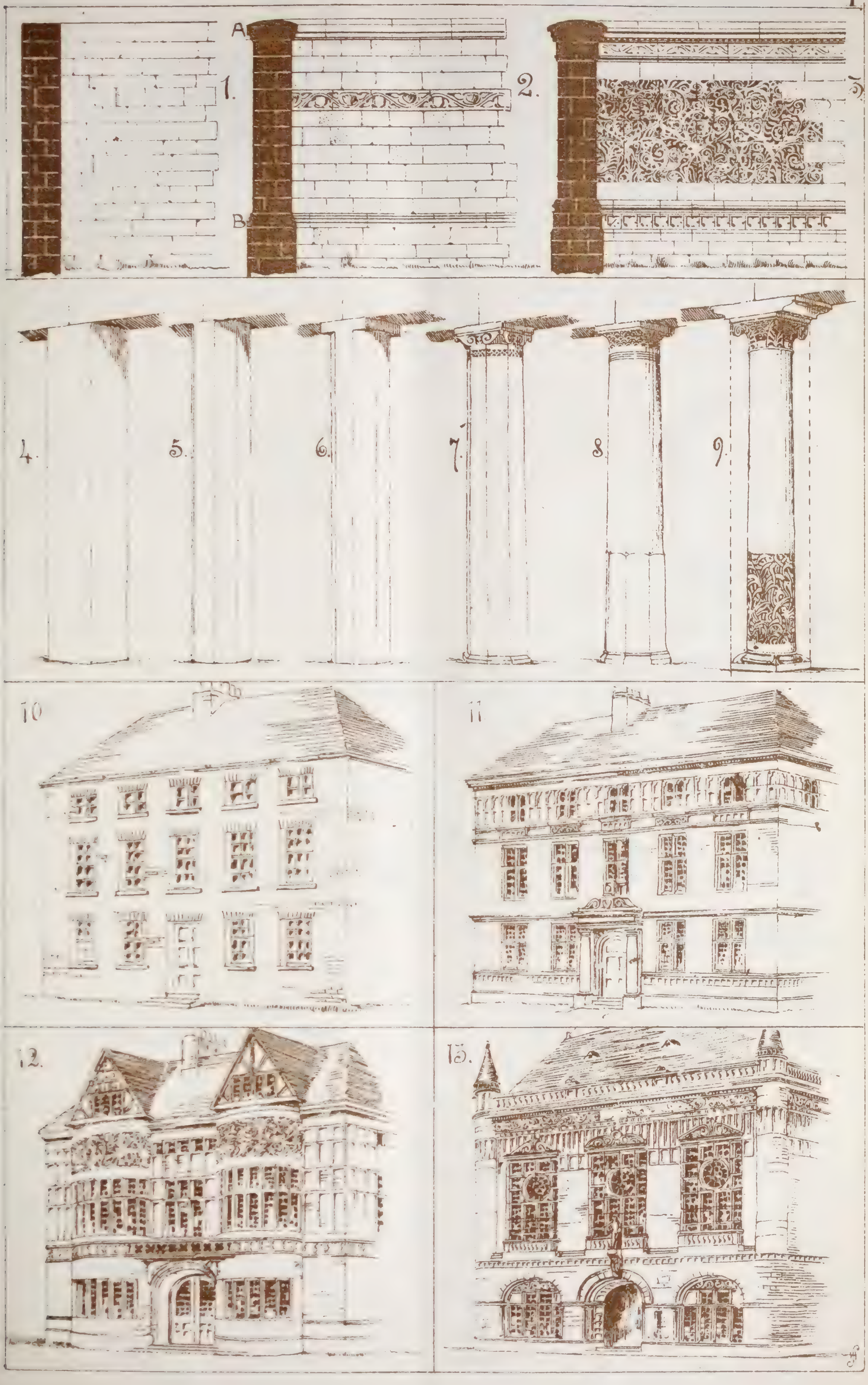

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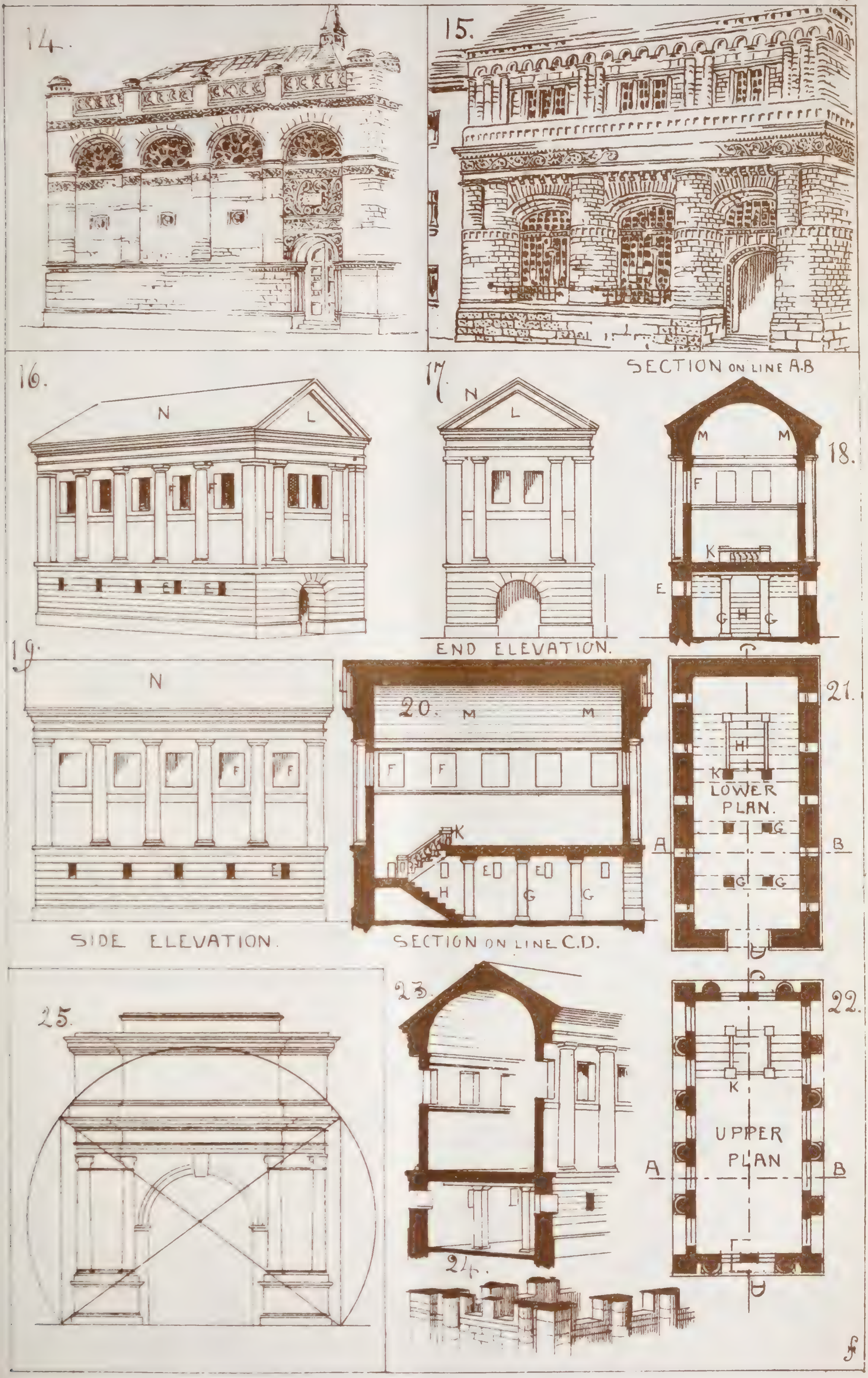
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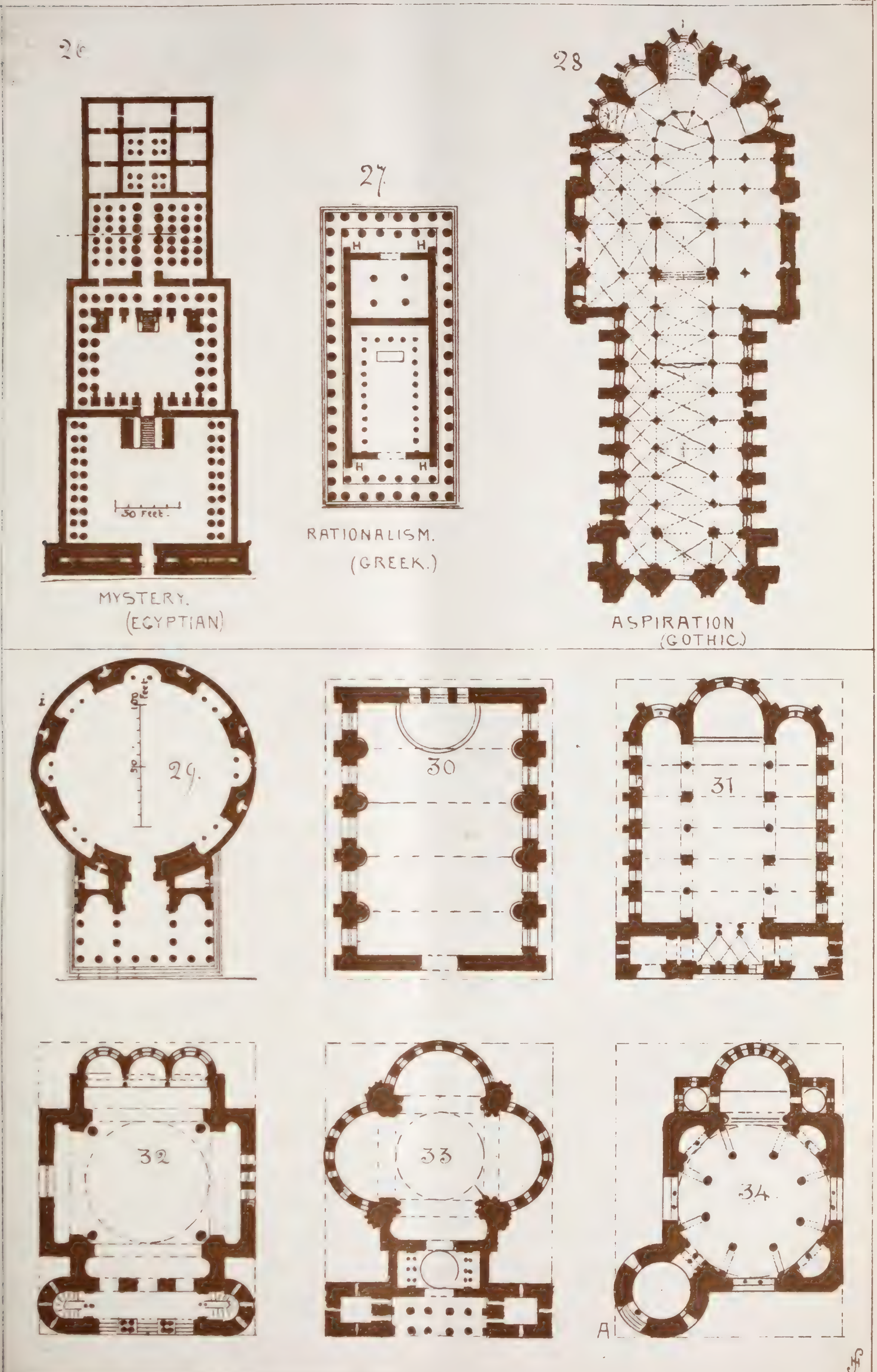
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Journal of the Society of Arts.

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FRIDAY, JANUARY 6, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first of the two Juvenile Lectures, on the "Application of Electricity to Lighting and Working," was delivered by Mr. William Henry Preece, F.R.S., on Wednesday evening, 4th inst. The lecture dealt with the electric light. It will be printed in the next number of the *Journal.*

The second lecture, treating of applications of electricity for the transmission and employment of motive power, will be delivered on Wednesday evening next, 11th instant, at 7 p.m.

Proceedings of the Society.

CANTOR LECTURES.

ELEMENTS OF ARCHITECTURAL DESIGN.

By H. H. Statham.

Lecture III.—Delivered December 12, 1887.

[The illustrations to this lecture are issued as a Supplement to the present number of the *Journal.*]

In the last lecture we considered some of the principal forms of architectural design as dealing with and as influenced by the constructive principle of the beam. We are now to consider it as influenced by the constructive principle of the arch.

Put in the simplest language, the arch may be described as a method of supporting materials above a void, or making them support each other, by their mutual compression; by jamming them together, so to speak, so that they cannot fall into or through the space below them. We may begin with two stones tilted against each other so as to meet in the middle, like our two rafters in Fig. 37 (Lecture II.); and it is obvious that here they cannot fall so long as the walls remain immoveable. If we want to bridge over a wider space than the two stones will cross leaning against each other, we may insert a third stone horizontally between the upper ends of the two leaning or rafter-like stones, and these two will support the third one between them as long as the walls against which they are abutted remain immoveable. Here we have made an important step towards the principle of the arch; and it is easy to imagine the principle carried further by little and little, until a large number of stones are supporting each other in the same manner over a void space narrower than the combined length of such stones if they were set out in a straight line, and which space therefore they cannot fall through so long as they are accurately fitted together and, and once more be it noted, so long as the walls which form their *abutment* remain unmoved.

The conditions of stability are, however, much more complicated when we come to consider an arch of many stones, than in the primitive form of two leaning stones and a horizontal one supported between them, which has been suggested as a first and simplest form of the arch. In this primitive case the pressures are very simple and easily calculated; in the case of an arch of many stones the pressures are very complex, nor in fact is there any quite decisive or authoritative theory, to the present day, as to the manner in which the pressures in an arch should be regarded. This want of certainty and unanimity as to theory is no doubt partly owing to the much greater difficulty of making and recording test experiments on the strength and the method of failure of arches, as compared with beams. The formulæ for the strength of beams, both wood and iron, in resistance to various strains, are now in a tolerably complete stage; the weights they will bear can be pretty certainly calculated, the manner in which they usually fail is known; but the theory in this case is the result of many series of experiments, which it is easy to make with beams. A beam

breaks under test at some one point, and when broken the two portions are still there to be practically examined; or it deflects to a certain extent, and its deflection, and the amount of "set" which it takes,* can be accurately measured. But an arch must be experimented on under much less favourable conditions for observation. Being of rigid and not of elastic materials, it does not give way gradually, but by a sudden crushing at one or another point, the behaviour of which must be watched at the moment; and when the arch has parted and fallen under its test, it has gone altogether as an arch; it is in fragments, and is of no use for further comparison or investigation as to its manner of failing. Rondelet's experiments are the most complete and important that have been made, and from them and other observations conclusions have been deduced which it is sufficient to state briefly and generally here, as we are mainly concerned here with the influence of the arch architecturally.

There is one difference in principle between our supposed primitive arch of three stones and the true arch, viz., that it is contrary to the principle of the true arch that the stones comprising it should be longer in the direction in the curve of the arch than in the direction of its thickness. The wedge-shaped stones (called *voussoirs*) composing a true arch act at certain points or under partial pressures like levers, one tending to thrust another round; and they have the more tendency to do this in proportion as they are long-shaped in the direction of the arch. And as the whole of the voussoirs composing an arch are in a state of compression one against another, it can easily be seen that pieces of material in compression, even apart from any arrangement in the arch form, are much more stable when subjected to compression on their sides than against their ends. Take three cubes like what are put in toy boxes of bricks, an inch square and, say, six inches long, lay them one over the other on their sides, and they will sustain without any disturbance of their position any weight up to their crushing point; but place them on each other end to end vertically, and a very small irregularity in the pressure will overturn their equilibrium; one will turn on the end of another, and the whole will come down. The whole of the pieces composing an arch are in a state of resistance to compression, and the flatter they are (within certain limits) in the direction at right angles to the line of thrust, the less likely they are to turn one upon another as on a fulcrum.

* "Set" is the term applied to a permanent deflection in a beam from which it does not recover.

The typical form of arch therefore is that shown on Fig. 77, the half-arch only being shown, whatever applies to the one half applying to the other, if we suppose it to be equally loaded. The voussoirs are wedge-shaped, with joints radiating from the centre from which the arch is struck, because only so can all their bearing surfaces be brought into contact; and they are deeper in the joint than on the *intrados* and *extrados*,* for the reason just given in the last paragraph. Now, the arch as shown there is a series of wedge-shaped pieces held up across a void by being jammed together; they need not necessarily be arranged in the form of a semicircle; they might be arranged in an ellipse (as at Fig. 80) or in a catenary curve (the reverse of the curve formed by a suspended chain with its links free to move on one another), or in several other curves; but it is important that they should be arranged in a symmetrical curve of some kind, not only for appearance, but for securing an even balance of pressures; and the circle, or segment of it, has been most used in the world's building work, as the easiest and simplest to construct. Now inasmuch as the stones forming the upper portion of the arch, and whatever is built upon them, have a definite weight, with nothing immediately under to support it, it is clear that weight must go somewhere; it is in fact transformed into an oblique thrust acting against the lower portion of the arch and tending to thrust out the arch and the wall which carries it. It will thus be seen what an important difference there is between the arch and the lintel in their effect on the substructures. The lintel, as we saw, exercises nothing but one simple vertical pressure on what is below it; the arch is constantly exercising an outward thrust upon the walls, tending to push them apart and to drop in between them itself; and this fact of the outward thrust of the arch was the main originating factor of what is known as the Gothic style of architecture, the greatest and most complete arched style of the world.

In estimating the extent and direction of this outward thrust of the arch, the old school of theorists used to consider the arch as built without mortar, and composed of voussiors

* The intrados is the line formed by the lower faces of the voussoirs; the extrados that formed by their upper faces.

infinitely smooth on surface and exercising no friction upon one another, so that the question was simply one of equilibrium of pressures. But this theory has been dropped in modern times, as being too far apart from the real facts of the case; for even if we leave the cementing materials out of account (as we perhaps ought), the friction of the voussoirs on one another is unquestionably a very important factor in the stability of the arch. The cementing material is practically an important one also, so much so that it is related of Brunel that when an arch which he had built fell down, instead of reconsidering the stability of its lines, he gave orders to build it up again in cement. But, in theory, cementing materials are only an additional safeguard against disturbance, not an element in the construction. But the friction of materials is a recognised power in engineering science, which has tabulated the slopes and angles at which different materials will retain their position by the action of friction as opposed to gravitation; and for stone as usually worked for building purposes the angle is about 30°. In Fig. 77 the upper joint at the fifth voussoir (from the springing of the arch) is at that angle, therefore we may take it the voussoir next above that joint would be just in a state of equilibrium between the action of gravitation and that of friction, or the arch up to the sixth joint (next joint below F) would remain in the position in which it was placed, overhanging and just ready to fall, but retained by the friction of the voussoirs on one another. If another voussoir is added, it then would fall in, unless met by an opposing force tending to keep it in its place; and such a force is represented by the upper portion of the arch, which directs a pressure outwards from the centre to the side, counteracting the pressure inwards at the lower voussoirs. We may now, with at all events approximate truth, state the condition of the arch in this manner: both portions of the arch, that below and that above F in Fig. 77 exercise both a vertical and a horizontal force. The vertical force in each portion represents the weight of the materials and of whatever superstructure may be placed upon the arch; the horizontal forces represent in the lower portion, A F, a tendency to fall inwards, and in the upper portion, B F, a tendency to thrust outwards, and a diagram approximately representing these opposing forces may be constructed in this manner; taking the mean line of the lower portion, A, produce it vertically till it meets, at C, the mean line of the upper portion produced horizontally from B; then bisect the angle by the line C F D, and draw E F G horizontally through F, and K F H vertically through F. The parallellogram, H B F G, may then be taken to represent the combined vertical and horizontal pressures of the portion F B of the arch, H F representing the vertical pressure, and F G the horizontal pressure; and similarly the parallellogram, A E F K, may be taken as representing the vertical and horizontal pressures of the lower portion A F of the arch, E F being the horizontal pressure (inwards) and F K the vertical pressure. Thus it will be seen that the horizontal pressure is much the greatest in the upper half of the arch, a great part of the weight of this portion being transformed into an outward thrust, while in the lower portion the vertical pressure is the greatest, a great part of this lower portion of the arch pressing nearly vertically on the walls. Consequently it will be seen that in a semicircular arch the greatest outward thrust is at a point about halfway between the crown and the springing of the arch; and this theory is in accordance with observed fact. When an arch of this shape gives way through being overweighted, it does so by rising at or about the part F, the lower portion being thrust outward (at F), and the crown simultaneously sinking (at B). If we take a different form, a moderately pointed arch (Fig. 78), the point F is relatively higher, and the horizontal pressure, F G, is proportionately smaller; point the arch still more (Fig. 79) and we have E F and F G similar, and this arch has practically no thrust, the inward and outward pressures being balanced. Take an opposite form, a low elliptical arch (Fig. 80), and we find the horizontal thrust of the upper portion (F G) greatly increased, and the inward thrust of the lower portion (E F) diminished, and its vertical pressure (F K) diminished also, so that this is an arch requiring a great deal of abutment to resist its spreading tendency.

In a semicircular arch, as at Fig. 77, the line of pressure tends outwards towards the extrados of the arch as we descend towards the springing, owing to the accumulating weight and pressure of the voussoirs above, and if the line of pressure gets outside the extrados, the arch is unstable and is nearly sure to give at that point; so that the arch in Fig. 77, if we suppose it to be stable as drawn there, would become unstable if the voussoirs were materially reduced in depth: and an arch such as this, if standing free, would require to be thickened towards the springing, as in the

dome section shown at Fig. 81, which practically amounts to raising the line of wall and raising the real springing of the arch to a higher point. In practice, however, such an arch as Fig. 77 is almost always built in a solid wall, and is filled up solid above the extrados; and in this case, if we suppose that arch with a solid wall over it as high as the crown of the extrados, the vertical weight of the wall above the haunches would be sufficient to counteract the outward thrust tending to make it rise at F: but there would still be some remnant of outward thrust left at the springing, and we must see that our vertical wall which supports the arch is strong and massive enough to resist this spreading tendency. If we suppose this arch to be prolonged along the whole length of a building in the form of a tunnel, we should then be obliged to build a very thick wall along the whole length of the building to resist the thrust of the arch. A roof so built, a single prolonged arch, is what is called a "waggon vault;" it is the simplest manner of vaulting a building, but it is a construction very wasteful of materials in consequence of the continuously thick walls which are required to carry it. How this is to be obviated, and the wall supports economised, we shall see just now when we come to speak of the vault.

But before going further, let us pause to point out why we have always spoken all along of stone as the material to be employed, and why the arch is so peculiarly a *masonic* form of building. In speaking of the Greek lintel, it was observed that this employment of stone as a horizontal beam resting on two points of support is the weakest way in which stone can be employed. It is subjected to a strain tending to break it across, and stone being a granular material, with no fibrous cohesion in its parts, is more easily broken in this way than in any other, more easily even than by tension, since there is a greater leverage exercised to break it.* But such a material as stone is strongest in its resistance to compression; in other words, it requires much greater force to crush it than to rend it, and in the arch the voussoirs are all subject to compression, and to compression only; and hence the arch is in an especial sense the form of building suitable for stone. Wood has much less resistance to compression than stone (most woods at least) and is in other ways less desirable; iron could be employed in arch building, but it would be much more costly than stone, much heavier, and it can be used in a much more economical and suitable manner in the girder form. The arch is the form for stone building; and it has this great practical advantage also over the trabeated style, for stone, that it does not presuppose the use of large blocks. In a beam style a small space is bridged by one large block (if we are confined to stone); in an arch style a large space is bridged by many small blocks.

We have just referred to the waggon vault as a form in which the arch presses equally on the wall along its whole length; before turning to other forms of vaulting, let us glance at another form of arch which also presses on the whole of its substructure wall, but under very different conditions, viz., the dome. This form of covering is that which would be formed if we suppose the half-arch, Fig. 77, to be turned round in a complete circle on B as its axis: it is an arch both ways, so to speak, its vertical section being a semicircle (usually) and its horizontal section a complete circle. This fact of its being composed of rings of horizontal arches or circles puts it under very different conditions from the arch: for when once a circle of the dome is completed horizontally, it cannot fall in. A dome may be built half-way up and then left as in Fig. 82; and while an arch left in that unfinished stage would fall in, not having the upper portion to oppose it, the dome so left cannot fall in, because, as will be seen from the plan of the upper ring beneath, Fig. 82, that upper ring is itself a horizontal arch, formed of stones which are wedge-shaped horizontally (as well as vertically). Hence a dome, though generally made of the section of a semicircular arch, for reasons of appearance, may be built in many forms of section in which an arch would not stand for a moment; it may even be built with the lower portion in a reversed curve convex to the interior, which would in fact be a very strong section, as it would exactly follow the line of

* The difficulty into which construction may be brought in the endeavour to use a comparatively coarse-grained stone in this manner, is illustrated in the big Doric portico—not without a certain illogical grandeur of its own—which was put up as the entrance to Euston Station, at a period when it was supposed that everything was to be Greek. Here the scale of the Doric order employed was so large that monolith stones could not be obtained easily which would carry across the openings, and so the architraves are actually in two stones welded together by iron cramps. It would be difficult to find a more pointed *reductio ad absurdum* of the fallacy of employing a style quite independently of, or in contradiction to, the mechanical capabilities of the material in which it has to be built.

pressure, which tends outwards towards the base of the dome, as towards the base of the arch. It has generally been felt, however, that the architectural grandeur of the dome is best realised in its simplest form of a perfect hemisphere, or such a shape at least as would make a perfect hemisphere to the eye; for there is much distortion of effect to be allowed for in looking up at a dome internally. When a circular dome is placed on a circular substructure, as in Figs. 84 and 85, the problem is an easy one; or when it is placed on an octagonal substructure, as indicated in the upper portion of the plan below Fig. 83, it will be seen that the octagon approaches so nearly to the circle as to leave only a little difference in plan to be adjusted by corbelling out * the walls till they meet the circle. But where the dome has to be built over a square, as indicated on the lower side of plan, Fig. 83, there remain two large angles to be filled up at B B (plan and sketch, Fig. 83). These portions, which are called pendentives, have been the scene of many interesting experiments in architectural design. The constructive principle in treating them may be resolved into two methods; that in which the space B is really a segment of a dome abutting against the extrados of two of the main arches as shown in Fig. 83 (which is a sketch of the domical construction of St. Sophia at Constantinople); or that in which the pendentive is corbelled out, or carried on an oblique arch thrown across the angle above the springing of the main arches. The corbelling out principle cannot be very well employed in this position except when the building is on rather a small scale; when it is apparently employed for effect, it would often be found that the structure is really domical: and there is no doubt that the domical treatment of the pendentive is the right one architecturally, because we are thus employing a homogeneous system of construction in every part of the building. In such a building as St. Sophia, where every portion is treated domically, we have the same system of architectural consistency as we find in the Greek style, where every space is covered by a lintel, and in the Gothic, where every one is covered by a pointed arch.

A good deal has lately been said in regard to the decorative treatment of the interior of the dome, in relation to the experiments in that direction made on the dome of St. Paul's. The subject is one of great interest, for there is no doubt that the interior surface of a great dome is one of the grandest and most suggestive positions that could be imagined for decorative treatment, but it appears to me that there are two mistakes which have operated to the prejudice of many of the dome decorative schemes that have been tried. One is the attempt to paint figure subjects on a dome illustrating a special history. No one can ever see these properly, and they are thrown away in such a position: any figures that are introduced should be of a simple and purely decorative character, with no attempt at giving special expression or meaning to them. This can never be appreciated in a dome of first-class dimensions and height, unless the figures are on so large a scale that they must in that case have the very serious drawback of dwarfing the whole scale of the architecture. Dome decoration, again, should never be so strong in colour as to bring down the apparent height of the dome. It may have a most disastrous effect in this respect. One object of any decorative treatment should be to assist the soaring effect of a dome interior, not to lower it. The other point in which I think mistakes have often been made, has been in dividing a dome for decoration into vertical sections, as Thornhill did in St. Paul's, and as was proposed to be done in the new scheme. This is contradicting the constructive character of a dome, which is a homogeneous semi-spherical vault, not a collocation of vertical arches. The arrangement undoubtedly renders the task of the decorator much easier, by dividing up his work into more manageable sections; but it is destroying the essential grandeur of the domical form; and any decoration which is applied to it should be on a scheme embracing the whole domical surface in one continuous design.

The dome is perhaps, in its finest aspect, more an internal than an external feature; notably so in St. Sophia, the great typical domed church, where externally the dome is hardly seen; and it is exceedingly difficult to treat a dome with equal effect internally and externally, as the treatment most effective in the one case is least effective in the other. Externally a dome is a feature whose lines are always tending away from the eyes; consequently, except from a great distance, it always seems lower than it really is in comparison with the rest of the building: every one knows

* "Corbelling out" consists in building out, in the upper portion, beyond the line of the lower wall, by building each course of stones a little projecting beyond the one next below it.

how the dome of St. Peter's disappears as you approach the west front, sinking into the building;* and on the other hand, if the dome is raised sufficiently to make a lofty centre to the composition externally, the result is that internally it is too lofty for effect; it loses its apparent size through the perspective diminution. Wren attempted to get over this difficulty in St. Paul's by making two domes, a timber and leaded one to show externally, and the real masonry dome to show internally; he has succeeded, there is no doubt, in producing a good effect both externally and internally, but it is at the expense of architectural and constructive truth.

Another anomaly in St. Paul's, the construction of the lantern which crowns the apparent dome externally, reminds us of another constructive point in which the dome differs from the arch. The latter is generally built up solid above the extrados, with a weight on the haunches; the dome, when made an external as well as an internal feature, cannot have any load on the haunches. Consequently it is a very weak form to carry any weight on the crown, which would naturally (as shown in speaking of the arch) cause the haunches to rise; and hence the difficulty of planting any important crowning feature on a dome. In the Florence cupola, Brunelleschi was so conscious of this that he made the cupola of a pointed section, the better to support the big lantern which he intended to mount upon it, and he also placed a tie round it at the haunches. It is true Brunelleschi's cupola, though often spoken of as a dome, is not a real dome; it is an octagonal cupola formed of eight arched gores meeting at the apex; but the treatment as to the carrying of the cupola would have been equally right if it had been a dome. In St. Peter's, the dome did begin to fail at the haunches in consequence chiefly of the weight of the lantern; and it had to be bandaged up with a chain (just where Brunelleschi had put his) to prevent further mischief. In St. Paul's Wren evaded the dilemma again by a sham; the lantern is carried on a solid cone rising from the base of the masonry dome, inside the timber dome, to the apex of the latter, and on that the lantern rests, not on the outer dome which appears to carry it, but which could not possibly do so. It is a very clever piece of construction, as solid as a rock; but somehow when we look at that leaded dome pretending to carry the lantern, which is really another construction protruded from beneath it, and which it could by no possibility carry, we feel our respect for what is in many senses a great building rather sensibly diminished.

The dome is a feature better fitted to be the architectural expression of a plan with a wide central area rather than the culminating point of a long plan, and everyone who compares the present plan of St. Paul's with the plan of Wren's first design—on a Greek cross plan, with a small *pronaos* instead of a long nave—will feel, I think, that the latter is much more essentially a plan for domical treatment than the one executed. The dome lends itself very well, however, to the treatment of a plan consisting of several square areas adjoining on the plan of a cross or some similar arrangement (but not on one straight line), as at Venice (Figs. 86, 86A) and Perigueux (Fig. 88). In this manner the dome has been largely and effectively used, and the combination of a central dome with smaller ones grouped round it usually produces a fine effect. On a great scale the dome appears to me to be, in spite of the difficulty of reconciling its internal and external treatment, the grandest architectural feature invented by man, and to have capabilities of higher treatment and finer effect than have ever yet been realised with it, externally at least. The Renaissance architects have had too much their own way with it, and have ignored its possible poetry of effect, and treated it in a too conventional and scholastic manner; but if an architect of genius had a chance, he might do more with the dome now than was achieved either in St. Peter's or St. Paul's.

Returning now to our waggon vault, let us see how the continuous vault, bearing on the walls for its whole length, became transformed into a vault exercising thrust only on certain portions of the wall, and how those portions were treated. The original form of the three-aisled mediæval church is found in the early Christian columnar basilica, as sketched in Fig. 89, plan 89A. This is, like the Greek temple, a purely trabeated construction, with its row of columns carrying the superstructure; only the columns have now ranged themselves inside the building, instead of outside. As the arch came into play in buildings of this class, the flat lintel roof became a waggon

* This is partly, however, the fault of an architectural quack named Carlo Madermo, who had interest enough with some Pope or other to get the job given him of lengthening out the nave of the church, so as to destroy the composition of dome and substructure as Michael Angelo left it.

vault, but with the points over the piers marked by transverse arches of greater thickness, as shown in the sketch of a bit from the Romanesque church at Valence, Fig. 90. Here also we see that a first step is made towards what was to become one of the great characteristics of Gothic architecture, the dividing out of the supporting piers into separate members each carrying its own portion of the design of the superstructure, architecturally speaking. Constructively, the pier remains as one mass, but it is broken up, for the sake of architectural expression, into separate members. As we see in Fig. 90, in place of the single column of the classic form, which does duty, on its own lines, in Fig. 89, the pier appears now in the guise of two much longer-proportioned columns, one of which carries the arch of the nave arcade, the other carries the transverse arch or rib which strengthens the roof at these points. But the roof, constructively, is still a continuous waggon vault, not differing essentially from the simple form of the waggon vault as shown in Fig. 91. The great step was taken when it was discovered that two such vaults could be built interpenetrating, as shown in Fig. 92. The Romans used this form of vaulting, but did not hit upon the right architectural expression for it. The state of things which this brings us to is, that all the thrust of the roof is taken off the walls except at the four points whence the cross arches and the oblique arches spring; A, B, C, D. If we can make those points secure, we can play with the interspaces as we choose. And how are we to support those points? Not by a feature like the column, for that is only a feature for resisting vertical pressure, and here we have a collection of pressures from different directions, but all (as they are from arches) thrusting outward. What we want is an opposing thrust inwards to meet them, and that is supplied by the *buttress*, the well-known form which is to Gothic architecture what the column is to Greek architecture; a form which, instead of standing vertically under the point of pressure, slopes outwards from it, and thus strengthens the construction in the direction in which strength is wanted, and at the same time gives the correct and logical architectural expression. But it was only by very slow steps that this transformation of the column into the buttress was completed. The Romans, in their arched constructions, habitually strengthened the point against which the vault thrust by adding columnar features to the walls, as shown in Fig. 108; thus again making a false use of the column in a way in which it was never contemplated by those who originally developed its form. In Romanesque architecture the column was no longer used for this purpose; its place was taken by a flat pilaster-like projection of the wall (plan and section, Fig. 109), which gave sufficient strength for the not very ambitious vaulted roofs of this period, where often in fact only the aisles were vaulted, and the centre compartment covered with a wooden roof. At first this pilaster-like form bore a reminiscence of a classic capital as its termination; a moulded capping under the eaves of the building. Next this capping was almost insensibly dropped, and the buttress became a mere flat strip of wall. As the vaulting became bolder and more ambitious, the buttress had to be made more massive and of greater projection to afford sufficient abutment to the vault, more especially towards the lower part, where the thrust of the roof is carried to the ground. Hence arose the tendency to increase the projection of the buttress gradually downwards, and this was done by successive slopes or "set-offs," as they are termed, which assisted (whether intentionally or not in the first instance) in further aiding the correct architectural expression of the buttress. Then the vaulting of the centre aisle was carried so high and treated in so bold a manner, with a progressive diminution of the wall piers (as the taste for large traceried windows developed more and more), that a flying buttress (see section, Fig. 110) was necessary to take the thrust across to the exterior buttresses, and these again, under this additional stress, were further increased in projection, and were at the same time made narrower (to allow for all the window-space that was wanted between them), until the result was that the masses of wall which in the Romanesque building were placed longitudinally and parallel to the axis of the building, have all turned about (Fig. 110, plan) and placed themselves with their edges to the building to resist the thrust of the roofing. The same amount of wall is there as in the Romanesque building, but it is arranged in quite a new manner, in order to meet the new constructive conditions of the complete Gothic building.

It will be seen thus how completely this important and characteristic feature of Gothic architecture, the buttress, is the outcome of practical conditions of construction. It is

treated decoratively, but it is itself a necessary engineering expedient in the construction. The application of the same principle, and its effect upon architectural expression, may be seen in some other examples besides that of the buttress in its usual shape and position. The whole arrangement and disposition of an arched building is affected by the necessity of providing counterforts to resist the thrust of arches. The position of the central tower, for instance, in so many cathedrals and churches, at the intersection of the nave and transepts, is not only the result of a feeling for architectural effect and the centralising of the composition, it is the position in which also the tower has the cross walls of nave and transepts abutting against it in all four directions: if the tower is to be placed over the central roof at all, it could only be over this point of the plan. In the Norman buildings, which in some respects were finer constructions than those of later Gothic, the desire to provide a firm abutment for the arches carrying the tower had a most marked effect on the architectural expression of the interior. At Tewkesbury, for instance, while the lower piers are designed in the usual way towards the north and south sides (viz., as portions of a pier of nearly square proportion standing under the angle of the tower), in the east and west direction the tower piers run out into great solid masses of wall, in order to ensure a sufficient abutment for the tower arches. On the north and south sides the solid transept walls were available immediately on the other side of the low arch of the side aisle, but on the east and west sides there were only the nave and choir arcades to take the thrust of the north and south tower arches, and so the Normans took care to interpose a massive piece of wall between, in order that the thrust of the tower arches might be neutralised before it could operate against the less solid arcaded portions of the walls. This expedient, this great mass of wall introduced solely for constructive reasons, adds greatly to the grandeur of the interior architectural effect. The true contructive and architectural perception of the Normans in this treatment of the lower piers is illustrated by the curious contrast presented at Salisbury. There the tower piers are rather small, the style is later, and the massive building of the Normans had given way to a more graceful but less monumental manner of building. Still the abutment of the tower arches was probably sufficient for the weight of the tower as at first built; but when the lofty spire was put on the top of this, its vertical weight, pressing upon the tower arches and increasing their horizontal thrust, actually thrust the nave and choir arcades out of the perpendicular towards the west and east respectively, and there they are leaning at a very perceptible angle away from the centre of the church—the architectural expression, in a very significant form, of the neglect of balance of mass in construction.

But while the buttress in Gothic architecture has been in process of development, what has the vault been doing? We left it (Fig. 92) in the condition of a round waggon vault, intersected by another similar vault at right angles. By that method of treatment we got rid of the continuous thrust on the walls. But there were many difficulties to be faced in the construction of vaulting after this first step had been taken, difficulties which arose chiefly from the rigid and unmanageable proportions of the circular arch, and which could not be even partially solved till the introduction of the pointed arch. The pointed arch is the other most marked and characteristic feature of Gothic architecture, and, like the buttress, it will be seen that it arose entirely out of constructive difficulties. These difficulties were of two kinds; the first arose from the tendency of the round arch, when on a large scale and heavily weighted, to sink at the crown if there is even any very slight settlement of the abutments. If we turn again to diagram 77, and observe the nearly vertical line formed there by the joints of the keystone, and if we suppose the scale of that arch very much increased without increasing the width of each voussoir, and suppose it built in two or three rings one over the other (which is really the constructive method of a Gothic arch), we shall see that these joints in the uppermost portion of the arch must in that case become still more nearly vertical; in other words, the voussoirs almost lose the wedge shape which is necessary to keep them in their places, and a very slight movement or settlement of the abutments is sufficient to make the arch stones lose some of their grip on each other and sink more or less, leaving the arch flat at the crown. There can be no doubt that it was the observance of this partial failure of the round arch (partly owing probably to their own careless way of preparing the foundations for their piers—for the mediæval builders were very bad engineers in that respect) which induced the builders of the early transitional abbeys, such as Furness and Fountains and

Kirkstall, to build the large arches of the nave pointed, though they still retained the circular-headed form for the smaller arches in the same buildings, which were not so constructively important. This is one of the constructive reasons which led to the adoption of the pointed arch in mediæval architecture, and one which is easily stated and easily understood. The other influence is one arising out of the lengthened conflict with the practical difficulties of vaulting, and is a rather more complicated matter, which we must now endeavour to follow out.

Looking at Fig. 92, it will be seen that in addition to the perspective sketch of the intersecting arches, there is drawn under it a plan, which represents the four points of the abutment of the arches (identified in plan and perspective sketch as A, B, C, D) and the lines which are taken by the various arches shown by dotted lines. Looking at the perspective sketch, it will be apparent that the intersection of the two cross vaults produces two intersecting arches, the upper line of which is shown in the perspective sketch (marked *e* and *f*); underneath, this intersection of the two arches, which forms a furrow in the upper side of the construction, forms an edge which traverses the space occupied by the plan of the vaulting as two oblique arches, running from A to C and from B to D on the plan. Although these are only lines formed by the intersection of the two cross arches, still they make decided arches to the eye, and form prominent lines in the system of vaulting; and in a later period of vaulting they were treated as prominent lines and strongly emphasised by mouldings; but in the Roman and early Romanesque vaults they were simply left as edges, the eye being directed rather to the vaulting surfaces than to the edges. The importance of this distinction between the vaulting surfaces and their meeting edges or *groins** will be seen just now. The edges, nevertheless, as was observed, do form arches, and we have therefore a system of cross arches (A B and C D† Fig. 95), two wall arches (A D and B C), and two oblique arches (A C and B D), which divide the space into four equal triangular portions; this kind of vaulting being hence called *quadripartite* vaulting. In this and the other diagrams of arches on this page, the cross arches are all shown in positive lines, and the oblique arches in dotted lines.

We have here a system in which four semicircular arches of the width of A B are combined with two oblique arches of the width of A C, springing from the same level and supposed to rise to the same height. But if we draw out the lines of these two arches in a comparative elevation so as to compare their curves together, we at once find we are in a difficulty. The intersection of the two circular arches produces an ellipse with a very flat crown, and very liable to fail. If we attempt to make the oblique arch a segment only of a large circle, as in the dotted line at 94, so as to keep it the same level as the other without being so flat at the top, the crown of the arch is safer, but this can only be done at the cost of getting a queer twist in the line of the oblique arch, as shown at D, Fig. 93. The like result of a twist of the line of the oblique arch, would occur if the two sides of the space we are vaulting over were of different lengths, *i.e.*, if the vaulting space were otherwise than a square, as long as we are using circular arches. If we attempt to make the oblique arches complete circles, as at Fig. 96, we see that they must necessarily rise higher than the cross and side arches, so that the roof would be in a succession of domical forms, as at Fig. 97. There is the further expedient of "stilting" the cross arches, that is making the real arch spring from a point above the impost, and building the lower portion of it vertical, as shown in Fig. 98. This device, o stilting the smaller arches to raise their crowns to the level of those of the larger arches, was in constant use in Byzantine and early Romanesque architecture, in the kind of manner shown in the sketch, Fig. 99; and a very clumsy and makeshift method of dealing with the problem it is; but something of the kind was inevitable as long as nothing but the round arch was available for covering contiguous spaces of different widths. The whole of these difficulties were approximately got over in theory, and almost entirely in practice, by the adoption of the pointed arch. By its means, as will be seen in Fig. 100, arches over spaces of different widths could be carried to the same height yet with little difference in their curves at the springing, and without the necessity of employing a dangerously flat elliptical form in the oblique arch. A sketch of the Gothic vault in this

* A *groin* is the edge-line formed by the meeting and intersection of any two arched surfaces. When this edge-line is covered and emphasised by a band of moulded stones forming an arch, as it were, on this edge, this is called a *groin-rib*.

† The "D" seems to have been accidentally omitted in this diagram; it is of course the fourth angle of the plan.

form, and as the intersection of the surfaces of pointed vaults, is shown in Fig. 101.

But now another and most important change was to come over the vault. The mediæval architects were not satisfied with the mere edge left by the Romans in their vaults, and even before the full Gothic period the Roman builders had emphasised their oblique arches in many cases by ponderous courses of moulded or unmoulded stone in the form of vaulting ribs. These, in the case of Norman building, were probably not merely put for the purpose of architectural expression, but also because they afforded an opportunity of concealing behind the lines of a regularly curved groin-rib, the irregular curves which were really formed by the junction of the vaulting surfaces. But when the vault became more manageable in its curves after the adoption of the pointed arch, the groin-rib became adopted in the early pointed vaulting as a means of giving expression and carrying up the lines of the architectural design. On its edge were stones moulded with the deep undercut hollows of Early English moulding, defining the curves of the oblique as well as of the cross arches with strongly-marked lines, and, moreover, falling on a level with each other in architectural importance; the oblique vault of the arch is no longer a secondary line in the vaulting design; on the contrary the cross arches are usually omitted, as shewn in Figs. 102 and 103 (view and plan of an early Gothic quadripartite vault); so that the cross-rib, which in the early Romanesque waggon vault (Fig. 90) was the one marked line on the vaulting surface, has now been obliterated, and the line of the oblique arch (E, F, Figs. 102, 103) has taken its place.

The effect of the strongly marked lines of the groin-ribs, radiating from the cap of the shaft which was their architectural support, seems to have been so far attractive to the mediæval builders that they soon endeavoured to improve upon it and carry it further by multiplying the groin-ribs. One of the stages of this progress is shown in Figs. 104, 105. Here it will be seen that the cross-rib is again shown, and that intermediate ribs have been introduced between it and the oblique rib. The richness of effect of the vault is much heightened thereby; but a very important modification in the mode of constructing it has been introduced. As the groin-ribs became multiplied, it came to be seen that it was easier to construct them first, and fill in the spaces afterwards; accordingly the groin, instead of being, as it was in the early days of vaulting, merely the line formed by the meeting of two arch surfaces, became a kind of stone scaffolding or framework, between which the vaulting surfaces were filled in with lighter material. This arrangement of course made an immense difference in the whole principle of constructing the vault, and rendered it much more ductile in the hands of the builder — more capable of taking any form which he wished to impose on it, than when the vault was regarded and built as an intersection of surfaces. There was still one difficulty, however, one slight failure both practical and theoretical, in the vault architecture, which for a long time much exercised the minds of the builders. The ribs of the vaulting being all of unequal length, they had to assume different curves almost immediately on rising from the impost, and as the mouldings of the ribs have to be run into each other ("mitred" is the technical term) on the impost, there not being room to receive them all separately, it was almost impossible to get them to make their divergence from each other in a completely symmetrical manner; the shorter ribs with the quicker curves parted from each other at a lower point than the larger ones, and the "mitres" occurred at unequal heights. The effort to get over this unsatisfactory and irregular junction of the ribs at the springing was made first by setting back the feet of the shorter ribs on the impost capping, somewhat in the rear of the feet of the larger ribs, so as to throw their parting point higher up; but this also was only a makeshift, which it was hoped the eye would pass over; and in fact it is rarely noticeable except to those who know about it and look for it. Still the defect was there, and was not got over until the idea occurred of making all the ribs of the same curvature and the same length, and intercepting them all by a circle at the apex of the vault as shown in Figs. 106, 107; the space between the circles at the apex of the vault being practically a nearly flat surface or *plafond* held in its place by the arches surrounding it; though, for effect, it is often treated otherwise in external appearance, being decorated by pendants giving a reversed curve at this point, but which of course are only ornamental features hung from the roof. If we look again at Fig. 104, we shall see that this was a very natural transition after all, for the arrangement of the ribs and vaulting surfaces

in that example is manifestly suggestive of a form radiating round the central point of springing, though it only suggests that and does not completely realise it. But here came a further and very curious change in the method of building the vault, for as the ribs were made more numerous, for richness of effect, in this form of vaulting, it was discovered that it was much easier to build the whole as a solid face of masonry, working the ribs on the face of it. Thus the ribs, which in the intermediate period were the constructive framework of the vault, in the final form of fan-vaulting came back to their original use as merely a form of architectural expression, meant to carry on the architectural lines of the design; and they perform, on a larger scale and with a different expression, much the same kind of function which the fluting-lines performed in the Greek column. The fan vault is therefore a kind of inverted dome, built up in courses on much the same principle as a dome, but a convex curve internally instead of a concave one, the whole forming a series of inverted conoid forms abutting against the wall at the foot, and against each other at their upper margins. This form of roof is wonderfully rich in effect, and has the appearance of being a piece of purely artistic work done for the pleasure of seeing it; yet, as we have seen, it is in reality, like almost everything good in architecture—the logical outcome of a contention with structural problems.

We have already noticed the suggestion, in early Gothic or Romanesque, of the dividing up of a pier into a multiple pier, of which each part supports a special member of the superstructure, as indicated in Fig. 90. The Gothic pier, in its development in this respect, affords a striking example of that influence of the superstructure on the plan which has before been referred to. The peculiar manner of building the arch in Gothic work led almost inevitably to this breaking up of the pier into various members. The Roman arch was on its lower surface a simple flat section, the decorative treatment in the way of mouldings being round the circumference, and not on the under side or *soffit* of the arch, and in early Romanesque work this method was still followed. The mediæval builders, partly in the first instance because they built with smaller stones, adopted at an early period the plan of building an arch in two or more courses or rings, one below and recessed within the other. As the process of moulding the arch stones became more elaborated, and a larger number of subarches one within another were introduced, this characteristic form of sub-arches became almost lost to the eye in the multiplicity of the mouldings used. But up to nearly the latest period of Gothic architecture this form may still be traced if looked for, as the basis of the arrangement of the mouldings, which are all formed by cutting out of so many square sections, recessed one within the other. This will be more fully described in the next lecture. We are now speaking more especially of the pier as affected by this method of building the arches in recessed orders. If we consider the effect of bringing down on the top of a square capital an arch composed of two rings of squared stones, the lower one only half the width (say) of the upper one, it will be apparent that on the square capital the arch stones would leave a portion of the capital at each angle bare, and supporting nothing.* This looks awkward and illogical, and accordingly the pier is modified so as to suit the shape of the arch. Figs. 111, 112, 113, and 114, with the plans B C D accompanying them, illustrate this development of the pier. Fig. 111 is a simple cylindrical pier with a coarsely-formed capital, a kind of reminiscence of the Doric capital, with a plain Romanesque arch starting from it. Fig. 112, shown in plan at B, is the kind of form (varied in different examples) which the pier assumed in Norman and early French work, when the arch had been divided into two recessed orders. The double lines of the arch are seen springing from the cap each way, in the elevation of the pier. If we look at the plan of the pier, we see that in place of the single cylinder it is now a square with four smaller half cylinders one on each face. Of these, those on the right and left of the plan support the sub-arches of the arcade; the one on the lower side, which we will suppose to be looking towards the nave, supports the shaft which carries the nave vaulting, and which stands on the main capital with a small base of its own, as seen in Fig. 112; a common feature in early work: and the half-column on the upper side of the plan supports the vaulting-rib of the aisle. In Fig. 113 and plan C, which represents a pier of nearly a century later, we see that the pier is broken up by perfectly detached shafts, each with its own capital, and each carrying a group of arch mouldings, which latter have become more elaborated. Fig. 114 and plan D show a late

* This was illustrated by diagrams on the wall at the delivery of the lecture.

Gothic fourteenth century pier, in which the separate shafts have been abandoned, or rather absorbed into the body of the pier, and the pier is formed of a number of moulded projections, with hollows giving deep shadows between them, and the capitals of the various members run into one another, forming a complete cap round the pier. This pier shows a remarkable contrast in every way to B, yet it is a direct development from the latter. In this late form of pier, it will be observed that the projection E which carries the vaulting-ribs of the nave, instead of springing from the capital, as in the early example, Fig. 111, springs from the floor, and runs right up past the capital; thus the plan of the vaulting is brought, as it were, down on to the floor, and the connection between the roofing of its building and its plan is as complete as can well be. In Fig. 113 the vaulting shaft is supposed to stop short of the capital and to spring from a corbel in the wall, situated above the limit of the drawing. This was a common arrangement in the "Early English" and "Early Decorated" periods of Gothic, but it is not so logical and complete, or so satisfactory either to the eye or to the judgment, as starting the vaulting-shaft from the floor line. The connection between the roofing and the plan may be further seen by looking at the portion of a mediæval plan given under Fig. 110, where the dotted lines represent the course of the groin-ribs of the roof above. It will be seen how completely these depend upon the plan, so that it is necessary to determine how the roof in a vaulted building is to be arranged before setting out the ground plan.

Thus we see that the Gothic cathedral, entirely different in its form from that of the Greek temple, illustrates, perhaps even more completely than the Greek style, the same principle of correct and truthful expression of the construction of the building, and that all the main features which give to the style its most striking and picturesque effects are not arbitrarily adopted forms, but are the result of a continuous architectural development based on the development of the construction. The decorative details of the Gothic style, though differing exceeding from those of the Greek, are, like the latter, conventional adaptations of suggestions from nature; and in this respect again, as well as in the character of the mouldings, we find both sides illustrating the same general principle in the design of ornament, in its relation to position, climate, and material; but this part of the subject will be more fully treated of in the next lecture.

We have now arrived at a style of architectural construction and expression which seems so different from that of Greek architecture, which we considered in the last lecture, that it is difficult to realise at first that the one is, in regard to some of its most important features, a lineal descendant of the other. Yet this is unquestionably the case. The long thin shaft of Gothic architecture is descended, through a long series of modifications, from the single cylindrical column of the Greek; and the carved mediæval capital, again, is to be traced back to the Greek Corinthian capital, through examples in early French architecture, of which a tolerably complete series of modifications could be collected, showing the gradual change from the first deviations of the early Gothic capital from its classical model, while it still retained the square abacus and the scroll under the angle and the symmetrical disposition of the leaves, down to the free and unconstrained treatment of the later Gothic capital. Yet with these decided relations in derivation, what a difference in the two manners of building. The Greek building is comparatively small in scale, symmetrical and balanced in its main design, highly finished in its details in accordance with a preconceived theory. The Gothic building is much more extensive in scale, is not necessarily symmetrical in its main design, and the decorative details appear as if worked according to the individual taste and pleasure of each carver, and not upon any preconceived theory of form or proportion. In the Greek building all the predominant lines are horizontal; in the mediæval building they are vertical. In the Greek building every opening is covered by a lintel; in the Gothic building every opening is covered by an arch. No two styles, it might be said, could be more strongly contrasted in their general characteristics and appearance. Yet this very contrast only serves to emphasise the more strongly the main point which I have been wishing to keep prominent in these lectures—that architectural design, rightly considered, is based on and is the expression of plan and construction. In Greek columnar architecture the salient feature of the style is the support of a cross lintel by a vertical pillar; and the main effort of the architectural designer is concentrated on developing the expression of the functions of these two essential portions of the structure. The whole of the openings being bridged by

horizontal lintels, the whole of the main lines of the superstructure are horizontal, and their horizontal status is as strongly marked as possible by the terminating lines of the cornice—the whole of the pressures of the superstructure are simply vertical, and the whole of the lines of design of the supports are laid out so as to emphasise the idea of resistance to vertical pressure. The Greek column, too, has only one simple office to perform, that of supporting a single mass of the superstructure, exercising a single pressure in the same direction. In the Gothic building the main pressures are oblique and not vertical, and the main feature of the exterior substructure, the buttress, is designed to express resistance to an oblique pressure; and no real progress was made with the development of the arched style until the false use of the apparent column or pilaster as a buttress was got rid of, and the true buttress form evolved. On the interior piers of the arcade there is a resolution of pressures which practically results in a vertical pressure, and the pier remains vertical; but the pressure upon it being the resultant of a complex collection of pressures, each of these has, in complete Gothic, its own apparent vertical supporting feature, so that the plan of the substructure becomes a logical representation of the main features and pressures of the superstructure. The main tendency of the pointed-arched building is towards verticality, and this vertical tendency is strongly emphasised and assisted by the breaking up of the really solid mass of the pier into a number of slender shafts, which, by their strongly marked parallel lines, lead the eye upward towards the closing-in lines of the arcade and of the vaulted roof which forms the culmination of the whole. The Greek column is also assisted in its vertical expression by the lines of the fluting; but as the object of these is only to emphasise the one office of the one column, they are strictly subordinate to the main form, are in fact merely a kind of decorative treatment of it in accordance with its function. In the Gothic pier the object is to express complexity of function, and the pier, instead of being a single fluted column, is broken up into a variety of connected columnar forms, each expressive of its own function in the design. It may be observed also that the Gothic building, like the Greek, falls into certain main divisions arising out of the practical conditions of its construction, and which form a kind of "Order" analogous to the classic order in a sense, though not governed by such strict conventional rules. The classic order has its columnar support, its beam, its frieze for decorative treatment. The Gothic order has its columnar support, its arch (in place of the beam), its decoratively-treated stage (the Triforium), occupying the space against which the aisle roof abuts, and its clerestory, or window stage. All these arise as naturally out of the conditions and historical development of the structure in the Gothic case as in the Greek one, but the Greek order is an external, the Gothic an internal one. The two styles are based on constructive conditions totally different the one from the other; their expression and character are totally different. But this very difference is the most emphatic declaration of the same principle, that architectural design is the logical but decorative expression of plan and construction.

Miscellaneous.

BOTANICAL GARDENS, NILGIRIS.

The following notes on some of the more interesting plants which have been introduced or grown in the Madras Government Botanical Gardens, on the Nilgiris, during the year 1886-87, are taken from the Report of the Director (Mr. M. A. Lawson), which has been received from the India Office:—

Broussonetia.—Cuttings of this plant were sent by Mr. Robertson, the Principal of the Agricultural College, Saidápet. They have all struck root, and are doing well, and will be planted out both at Ootacamund and at Coonoor, in both of which places I think they ought to thrive.

2. *Oxandra virgata.*—The plants sent by the Agri-Horticultural Society, Madras, are healthy and growing; but are not yet sufficiently advanced to render it desirable that they should be put out at once.

3. *Cuprea.*—Although 150 or 200 plants of this species, nearly allied to cinchona, were raised from seed which was sent from Kew two years ago, none of them have done as well as I could wish. They have been planted out on the Naduvatum, Hooker, and Wood estates, and at Barliyár, but in none of these places are they growing well. I think the situation in every instance is too high and cold, or too dry.

4. *Teff. Eragrostis Abyssinica.*—The seed of this valuable fodder, which was received from Kew, has been sown both at Ootacamund and at Coonoor. The crop growing at Ootacamund has been sadly

injured by the grub of the cockchafer, while at Coonoor the plant has suffered from want of rain. Another year, if I can harvest good seed from the present crop, I shall sow later in the season.

5. *Ullucus tuberosus.*—This did very well during the past year in Ootacamund. The plants yielded a large number of fine tubers, and may become a welcome addition to our present vegetables, but it is never likely to equal in value the potato.

6. *Hop.*—I am sorry to have to report that the results connected with the cnltivation of the hop have been anything but satisfactory. I am afraid that neither the soil nor the climate of the Nílgiris suit it.

7. *Arracacia Esculenta.*—This plant has done well, both at Ootacamund and at Barliyár, showing that it is capable of thriving under great variations of temperature. The tubers are fairly agreeable to the taste.

8. *Cochin China tuberous-rooted vine.*—I have nothing further to report on this; the plants at Barliyár have flowered again, bnt have not set any fruit.

9. *Medicinal Rhubarb.*—I have tried growing this plant under many different circumstances, but have only succeeded in growing it satisfactorily when it has been provided with an abundance of lime, and from this I argue that it is not likely either to prove a profitable crop on these hills, which are almost entirely destitute of that mineral. Should it be able to withstand the heat of the plains, there is no reason why it should not successfully be grown in the neighbourhood of Coimbatore.

10. *Ipecacuanha.*—The stock of this most important medicinal plant has during the past year been increased from about 200 to over 700 plants, and the greater number of these, as Government have sanctioned the proposal, will be put out in the Government teak forest at Nilambúr. As mentioned in my last year's report, the few that had been planted three years ago in this forest are growing vigorously, and I have little doubt but that the soil and climate of Nilambúr will suit them far better than those of Barliyár. Last autumn it was reported that the stock of ipecacuanha in the European market was almost exhausted, and that there were faint prospects of this stock being much increased by fresh imports from abroad, and it was further reported that the price of the drug had risen from half-a-crown to ten shillings a pound. Whether this sudden failure in the supply of the ipecacuanha drug is due to the plant having been uprooted in its natural habitat, or whether it is due to some commercial ring having been formed, I am not able to state, but it is certainly very desirable that the plant which produces the best known cure for dysentery, a complaint so common in India, should, if possible, be grown in the country.

11. *Naregamia alata.*—This is a low growing plant belonging to the order Meliaceæ, and is found in great abundance on the West Coast from Bombay to Cochin, and probably farther south still. It has been called the "Goanese Ipecacuanha," and is said to be used largely by the natives in cases of rheumatism and fever. Surgeon-General Bidie is having the drug tried in Madras, with the view of finding out if it resembles the true ipecacuanha in its action in cases of dysentery and as an emetic. Mr. Hooper has made a chemical examination of *Naregamia* and has found an alkaloid, which he proposes to call "Naregamine."

12. *Gymnema sylvestre.*—This and many other species of the same genus have the property of paralysing the palate, so that it is impossible to be conscious of the ordinary taste experienced after eating substances, which are eithei bitter or sweet. Mr. Hooper, as will be seen from his report, has made a careful analysis of the leaves of *Gymnema sylvestre*, and finds that this peculiarity resides in an organic acid, which he has extracted from them and called gymnemic acid.

13. *Cyphomandra battacea.*—This grows well at Coonoor, and bears a very agreeably flavoured fruit about the size of a hen's egg. It belongs to the order Solanaceæ, is a native of South America, and sometimes goes under the name of the "tree tomato."

14. *Castilloa Elastica.*—This India rubber-producing tree flowered for the first time last year. The seeds were sown, and germinated freely, so that there can be no doubt about our being able to establish this tree permanently in India.

TRANSMISSION OF POWER BETWEEN BODIES MOVING AT DIFFERENT VELOCITIES.

A few months ago there was exhibited, in the Society's reading-room, a working model of an application to railway working of what the inventor calls "division of the mass." In causing a body, moving at a high velocity, to communicate motion to another at rest, or moving at a lower velocity, he splits one of them up into parts all the more numerous, and therefore tenuous, as the difference in velocity is greater; and this is accomplished by causing one of the parts to take the form of a brush composed of metal fibres.

In applying this principle to the transmission of motion for driving machinery, a disc, fitted with segmental brushes, is slid laterally along the shaft, so that the fibres come into contact with radial projections on a second disc; and, although the contact is made instantaneously, the action is exerted gradually, owing to the flexibility of the fibres. That is to say, the full power is communicated without any shock.

A similar arrangement, but with one of the discs fixed, serves as a brake for arresting motion, and this again without shock but with gradually increasing action. Where space is very much circumscribed, the clutch and the brake may be combined, by fitting a

disc with brushes on one side, and projections on the other, so that it may be brought by a lever against a second disc for transmitting motion, and against a third, fixed, for stopping it.

Safety appliances for arresting the descent of mine cages, in the event of the rope breaking, have hitherto depended upon the entrance of claws into the guides, or the clipping of the latter, or the wedging of the cage between the guides.

In this application of the system, the guides of the shaft are fitted with corrugated iron plates, and the sides of the cage with steel brushes. In the normal state of working, the brushes are kept clear of the guides, but, should the rope break, a small brush, fitted on a sector, constantly rubbing against the corrugations of the guides, aided by a spring or counter weight, brings the main brushes into contact with the guides by a link arrangement, like that of the parallel ruler, thus arresting the cage, and holding it suspended until the brushes are gradually relaxed, for "braking" the cage slowly down to the next landing.

Many attempts have been made to cause a locomotive, running at full speed, to exert such a mechanical action as would set a signal to danger, so as to protect the train from another following in the rear. By fitting the engine with a steel brush, attached to the axle-boxes, so as to preserve a uniform height with respect to the rails, a stationary lever may be gradually moved, so that the signal is set at "danger" without shock. Moreover, by means of another brush, in the event of the engine being turned upon the wrong line, a lever may be made to shut off the steam, apply the brakes, blow the whistle, or move an index on a dial, recording a neglect of duty, or may exert these four actions simultaneonsly.

All the above applications of this principle—"the division of the mass"—have been tested experimentally, the last-named by the model above referred to. The clutch arrangement has transmitted six horse-power from a petroleum motor, making 200 revolutions a minute, to a dynamo making 2,000 revolutions, while applications to industrial purposes are now being made, both in this country and in Belgium. The inventor of the system is M. Raymond Snyers, Ingénieur des Mines, du Génie Civil, et des Arts et Manufactures, of the Louvain University.

Correspondence.

STATISTICS IN TURKEY.

It is gratifying to find that at least one department of State is now publishing a regular annual statistical report of the number and quantity of articles imported and exported, the last of which is for the Turkish financial year ending February 28th, 1887. Although in the general compendium which accompanies the statistics, the Custom-house credits each country with the gross values of its trade, yet it is to be regretted that in the detailed specification of the original report the same *modus operandi* should not have been adopted, as it would have been of material interest to know the fluctuations that take place in the imports and exports of the diverse articles of merchandise, &c. Failing this, I limit myself to the general compendium which closes the official report (p. 158).

Taking in round numbers, I have calculated at the rate of 100 piastres to the Turkish lira, while payments at the Custom-house are accepted at the rate of 103 piastres to the lira, therefore the above gross totals are naturally reduced by 3 per cent.

General Remarks.

1. The amounts assigned to each country do not represent merchandise actually drawn from or destined for that country. It is specially stated that the proportions thus assigned comprise merely the value of goods shipped from or destined for one of the ports respectively belonging to those countries; hence the low figure of the German trade with Turkey.*

2. Being, as Turkey is, eminently an agricultural country, the growth or decline of its selling and purchase powers entirely depends upon its harvest, as well as the demands in the European markets for its produce, as will be seen from the following items:—

The imports of 1301, as compared with those of the previous year, show a decrease, as I remarked in my last report. Although the harvest was fairly good, and the shipping rates low, that year (1885-6), the decrease in imports amounted to £T633,955, and in exports to £T721,909, while last year (1886-7) the harvest was good, and the imports have once again increased by £T699,562, and the exports by £T631,035. What influences detrimentally affect the development of our trade is the high transport charges, whether by rail or camel, *e.g.*, a ton of goods to London can be shipped for 10s., while 40 miles by rail costs about 15s., besides a number of petty difficulties placed in the way of merchants.

3. The amounts of Customs dues levied upon merchandise shipped from Turkey to Egypt, and *vice versâ*, are collected at the port of embarcation, and admitted, free of duty, at the port of destination, therefore, the above amounts allotted to Egypt comprise merely those goods upon which duty has not been paid at the port of embarcation.

4. Arms, ammunition, and all kinds of military and naval equipment, also articles destined for all other departments of State (whether central or provincial) the foreign diplomatic representatives and

* Such being the case, the amounts apportioned to the different countries becomes illusory, and of little value beyond a precarious guess.

TABLE No. I.—Imports.

Names of Countries.	1301. Value of articles imported.	1302. Value of articles imported.	Difference.	Observations.
	£T.	£T.	£T.	
England	8,763,431	8,940,282	+ 176,851	Customs dues levied are 8 per cent. *ad valorem* on imports, and 1 per cent. on exports, consequently 8 per cent. should be added to the total imports.
Germany	26,928	25,139	— 1,788	
Austria-Hungary	3,919,840	4,176,004	+ 256,163	
Italy	606,209	635,143	+ 28,934	
Spain	67	5	— 62	
Persia	544,933	488,679	— 65,254	
Sweden and Norway	56,347	14,731	— 41,616	
America	188,042	123,528	— 64,513	
Belgium	295,561	383,956	+ 88,388	
Bulgaria	293,584	493,706	+ 200,121	
Tunis	80,162	77,429	— 2,732	
Denmark	...	141	+ 141	
Russia	1,758,499	1,786,144	+ 27,645	
Roumania	639,210	322,389	— 316,820	
Samos	1,312	1,338	+ 25	
Servia	84,863	72,663	— 12,200	
Holland	26,660	33,898	+ 7,238	
France	2,316,888	2,690,799	+ 373,911	Both exports and imports to Egypt pay 8 per cent. *ad valorem;* it is the same with Samos and Bulgaria.
Montenegro	8,261	6,290	— 1,971	
Egypt	32,850	19,573	— 13,276	
Greece	360,005	411,384	+ 51,379	
	20,003,669	20,703,231		

TABLE No II.—Exports.

Names of Countries.	1301. Value of articles exported.	1302. Value of articles exported.	Difference.	Observations.
	£T.	£T.	£T.	
England	4,555,567	4,349,237	— 206,329	
Germany	1,305	7,298	+ 5,993	
Austria-Hungary	1,132,200	1,117,183	— 15,017	
Italy	370,239	373,513	+ 3,273	Customs dues levied on exports are 1 per cent., *ad valorem*, consequently this must be added to the total exports.
Spain	748	2,092	+ 1,343	
Persia	8,418	10,705	+ 2,287	
Sweden and Norway	62	...	— 62	
America	121,474	153,339	+ 31,865	
Belgium	10,719	283	— 10,436	
Bulgaria	19,104	23,255	+ 4,150	
Tunis	654	124	— 529	
Denmark	123	1,331	+ 1,207	
Russia	385,652	307,157	— 78,494	The export of tobacco during the year 1302 amounted to 11,688,052 kilogram., at an average of 5 piast. = £T584,402 60c.
Roumania	109,907	107.707	— 2,199	
Samos	3,287	3,322	+ 35	
Servia	5,788	10,197	+ 4,409	
Holland	82,947	127,711	+ 44,763	
France	3,724,992	4,738,022	+ 1,013,030	
Montenegro	3,953	4,340	+ 386	
Egypt	1,003,804	905,279	— 98,525	
Greece	535,304	465,191	— 70,113	
	12,076,257	12,707,295		

consular body, agricultural machinery and implements, railway plant and machinery for newly-constructed lines, &c., are allowed to enter free of duty. Consequently such articles are not included in the above valuation, nor is the export of tobacco which pays no export duty, &c. Therefore, adding for all contingencies, as I did in my previous report, twenty per cent. to the gross amounts of imports, and the value of tobacco exported, to the general exports, the new gross trade of Turkey will stand thus. Imports—£T20,703,231 + 20 per cent. £T4,140,646 + amount of duty levied 1,571,456 = gross total £T26,415,333. Exports—£T12,707,295 + value of tobacco, 584,402 + duty levied 175,185 = gross total, £T13,466,882.

S. STAB,
Corresponding Member, Society of Arts.
Smyrna, 12th November, 1887.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

JANUARY 18.—"Methods of Taking the Ballot." Three papers by JOHN LEIGHTON, JAMES WITHERS, and JOHN IMRAY. The ATTORNEY-GENERAL, M.P., will preside.

JANUARY 25.—"Theatres and Fireproof Construction." By WALTER EMDEN.

FEBRUARY 1.—"The Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS.

FEBRUARY 8.—"The Continuation of Elementary Education." By W. LANT CARPENTER, B.A., B.Sc.

FEBRUARY 15.—"Type-writers and Type-writing." By JOHN HARRISON.

FEBRUARY 22.—"The Technical Education Bill." By SWIRE SMITH. PROF. SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

Dates to be hereafter announced :—

"Technical Instruction in Agriculture." By PROF. JOHN WRIGHTSON.

"Machine Tools for Boot and Shoe Manufacture." By JOHN W. URQUHART.

"Framework Knitting." By W. T. ROWLETT.

"Locks and Safes." By SAMUEL CHATWOOD.

"Telescopes for Stellar Photography." By SIR HOWARD GRUBB, F.R.S.

"The Measurement of Electrical Currents." By PROF. GEORGE FORBES, F.R.S.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 31. — "The Monumental Use of Bronze." By J. STARKIE GARDNER, F.G.S. E. J. POYNTER, R.A., will preside.

FEBRUARY 14.—"Principles of Design, as applied to Bookbinding." By HENRY B. WHEATLEY. SIR GEORGE BIRDWOOD, K.C.I.E., LL.D., M.D., will preside.

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

APRIL 24.—

MAY 8.—"What style of Architecture should we follow?" By WILLIAM SIMPSON.

MAY 29.—"Persian Textiles." By CECIL SMITH.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 17.—"The Colonies and Dependencies of the Netherlands and of Portugal." By A. J. R TRENDELL, C.M.G.

FEBRUARY 7.—"British Columbia." By HENRY COPPINGER BEETON, Agent-General for British Columbia.

MARCH 6.—"South African Gold Fields." By W. H. PENNING, F.G.S.

MARCH 27.—

APRIL 17.—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

JANUARY 27.—"The Public Health in India." By Mr. JUSTICE CUNNINGHAM, of the High Court of Judicature, Calcutta. SIR DOUGLAS GALTON K.C.B., F.R.S., will preside.

FEBRUARY 10.—"Facts regarding the Religions of India, and their influences on the moral progress of the people." By SIR WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D.

FEBRUARY 24.—

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras.

MAY 4.—

The above dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE I.—JANUARY 30.—Yeast an organised cell.—Considered as a plant.—Why classed among plants.—How to be studied.—Phenomena connected with the growth of the cell.—Fermentation.—Kind of fermentation related to character and quality of yeast.—Conditions necessary to healthy growth.—Classification of the pure yeast cell among plants.—Its relation to the higher orders of plants.—Resemblances and differences.—How these are accounted for.—Its assimilating powers compared with those of the higher plants.—Yeast classed among the lower forms of vegetal life.—A fungus.—Its position among fungi.—A parasite or saphrophyte.—The characteristic features of its class.—Its relation to the other members of its class higher and lower in the scale.—Hyphal, sprouting and fission fungi.—Fungi capable of inciting fermentation and putrefaction.—Fungi capable of inciting alcoholic fermentation.—The yeast species defined.—Phylogeny.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R A., on Thursday evenings, February 2nd, 9th, and 16th.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 9...Société Nationale des Professeurs de Français en Angleterre (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Annual Congress.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p m. Sir Robert S. Ball, "Invisible Stars."

TUESDAY, JAN. 10...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Paper by the late Hamilton Goodall on "The Use and Testing of Open-hearth Steel for Boiler-making."

Photographic, 5A, Pall-mall East, S.W., 8 p m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Henry Balfour, "The Evolution of a Characteristic Pattern on the Shafts of Arrows from the Solomon Islands." 2. Miss A. W. Buckland, "Tattooing." 3. Mr. Sydney B. J. Skertchly, "The Occurrence of Stone Mortars in the Ancient (Pliocene?) River Gravels of Butte County, Calfornia."

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Colonial Inst., Prince's-hall, Piccadilly, W., 8 p.m.

WEDNESDAY, JAN. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lecture.) Mr. W. H. Preece, "The Applications of Electricity to Lighting and Working." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Mr. R. D. Oldham, "On the Law that governs the Action of Flowing Streams." 2. Rev. A. Irving, "Supplementary Notes on the Stratigraphy of the Bagshot Beds of the London Basin.". 3. Rev. A. Irving, "The Red-Rock Series of the Devon Coast Section."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m.

Huguenot, Criterion, Piccadilly, W., 8 p.m. 1. Mr. W. Page, "Notes on Huguenots in Portugal." 2. Mr. F. P. Labilliere, "History of a Huguenot Family."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7 p.m. 1. Adjourned Discussion on Mr. O. Imray's Paper. 2. Adjourned Discussion on Mr. E. Carpmael's paper. 3. Mr. A. M. Clark, "The International Convention as it affects the Granting of Patents of Communication."

THURSDAY, JAN. 12...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture V.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 13...Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Robert J. Money, "Railway-Engineering in British North America."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, JAN. 14...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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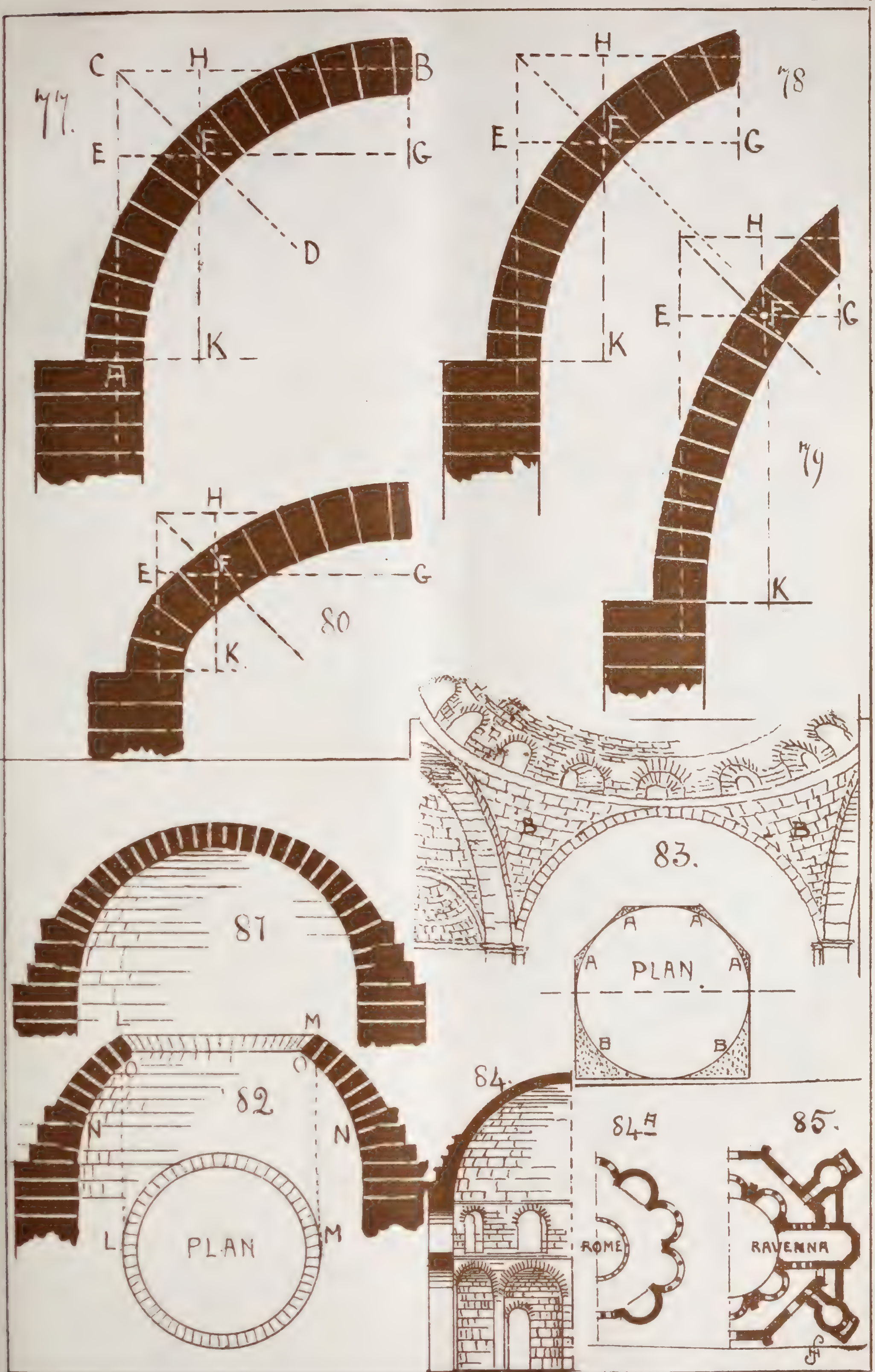
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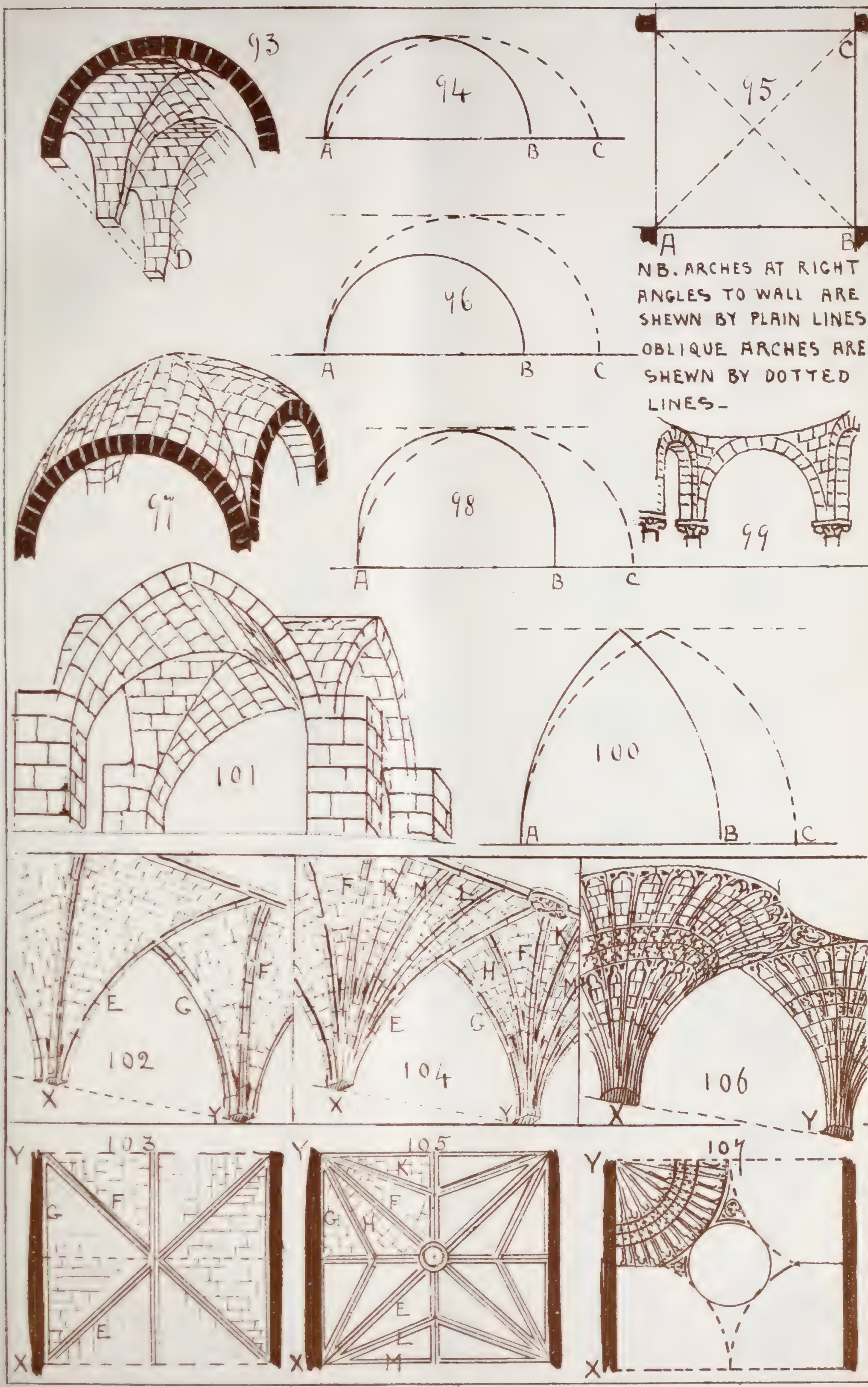
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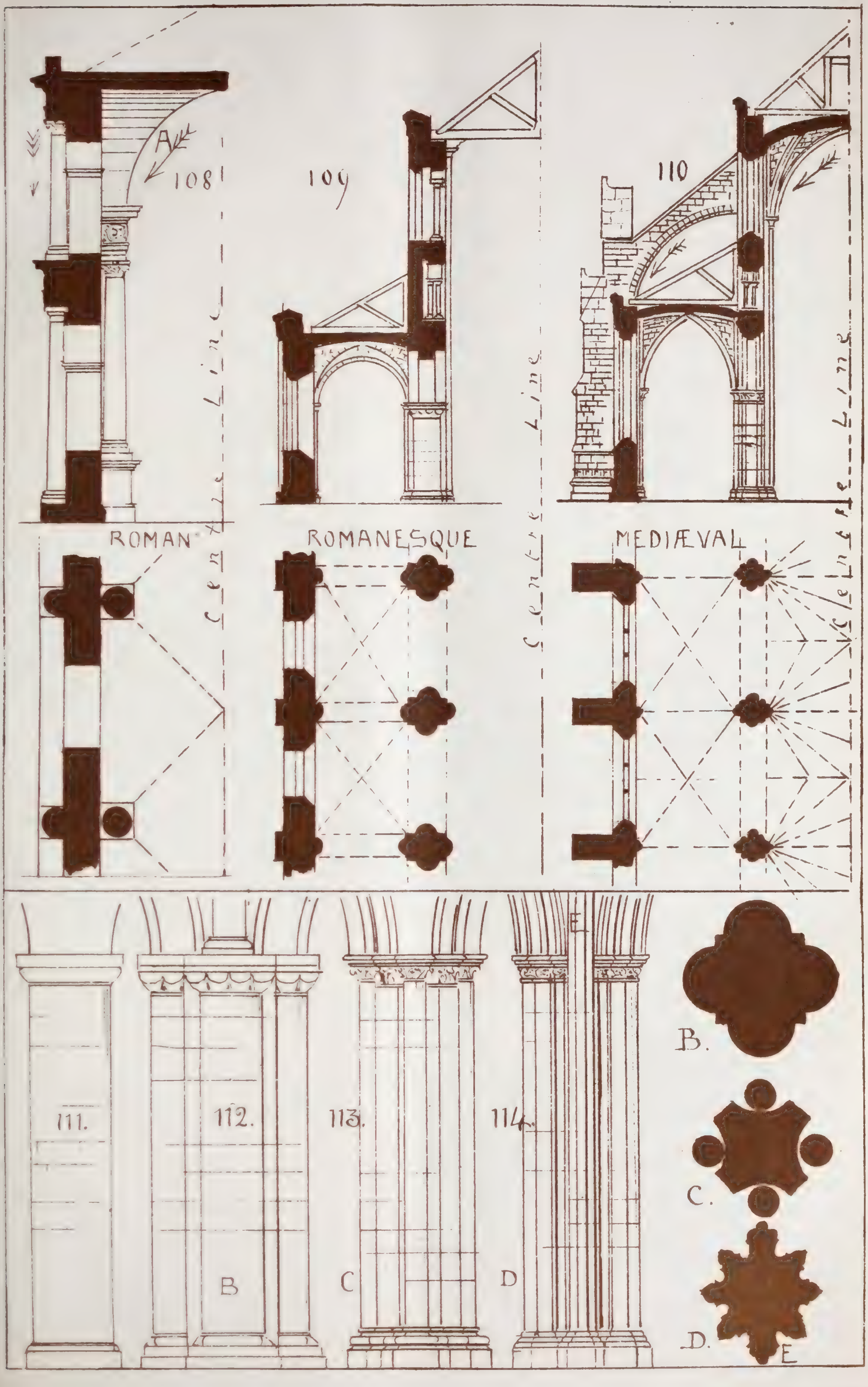
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Journal of the Society of Arts.

No. 1,834. Vol. XXXVI.

FRIDAY, JANUARY 13, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The second of the two Juvenile Lectures on the "Application of Electricity to Lighting and Working," was delivered by Mr. William Henry Preece, F.R.S., on Wednesday evening, 11th inst., in which the lecturer dealt with the applications of electricity for the transmission and employment of motive power. The lecture will be printed in the next number of the *Journal*.

A cordial vote of thanks was passed to the lecturer on the motion of the Chairman (Mr. W. Anderson).

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ELEMENTS OF ARCHITECTURAL DESIGN.

By H. H. Statham.

Lecture IV.—Delivered December 19, 1887.

[The illustrations to this lecture are issued as a Supplement to the present number of the *Journal*.]

The decorative treatment of architecture may be considered under two heads, that which is included under the definition of *mouldings*, or modifications of the surface in order to give variety of light and shade, and that which comes under the head of carved ornament. Mouldings are not, it is true, in general classed as "decorative" work, but they are so classed here inasmuch as they form an important branch of the treatment of details in architecture, the subject which has been reserved for special consideration in this lecture, in distinction from the broad principle of treatment of the whole building in reference to its general plan and construction.

A moulding may be defined as a modelling of the surface of building material, in a continuous and parallel direction, in order to produce from it lines of contrasting lights and shadows which aid in giving force and expression to the main lines of the structure. If we suppose an opening, such as a square-headed window opening, formed simply of three stones squared on section, two set upright and the third set across them, the outer edges of these stones will present to the eye a sharp thin edge formed by the meeting lines of the two surfaces of the stone, that which is at right angles to the wall plane and that which is on the wall plane, and which two surfaces are always necessarily under different conditions of lighting, one in fuller light than the other, the meeting of the two differently lighted planes of surface alone producing the effect of a line, which but for the varied intensity of light on the two surfaces would be barely discernible. Under some circumstances this simple edge is all that is required in that position. If it be desired, however, to give greater force and prominence to this defining edge of the window-jamb,* this can be accomplished by working this otherwise fine edge into the shape, for instance, of a quarter-round roll, sinking this roll a little below the surface of each face of the stone so as to leave, at each extremity of the roll, a little strip at right angles to the inner face of the stone. This strip, which is called a *fillet*, is a feature which occurs in mouldings of all schools, and serves, where necessary, as a defining boundary between one moulding and another, or as marking and emphasising the break between the moulding and the main surface of the stone. If, for instance, we merely rounded the edge of the stone, and let our quarter-roll die into the surface each way, we should hardly have anything which could be

* In building phraseology, "jamb" is the *side* of any opening in a wall, or that portion of the thickness of the wal that becomes visible when the opening is cut through.

truly called a moulding; we should not see where it began and ended; we should merely have blunted the sharp edge of the angle. But with the quarter-roll and the little strip at right angles to the roll at each extremity of it, we have now, in place of the thin edge of the original jamb, several distinct lines round the edge of the window, marking it and calling attention to it much more prominently than before. The two thin strips or fillets each make their own sharply defined line of light or shadow, according to the direction in which the light strikes them, and between them the roll moulding produces a more varied and broad gradation of light, a high light on the more prominent portion of its surface, shadowing off into half-lights as the surface recedes from the light. All mouldings are composed of these two classes; surfaces which produce graduated lights, and surfaces which produce sharp and defined lines of light or shadow, as the case may be. The method just described, of sinking the roll and leaving a fillet at each side of it, is the method characteristic of classic architecture, but not unfrequently used in early Gothic also; another method, quite different in effect and especially characteristic of Gothic architecture, is shown in Fig. 129, where it will be seen the roll at the edge of each projection is worked from the main surface of the stone, and its inner limits are defined by the stone being cut away so as to continue the roll moulding further round, and make a three-quarter instead of a quarter roll. This is a method particularly suited to a climate where there is a comparatively dull light; it produces a dark shadow behind the roll and throws it up strongly: under a very strong sunlight it would be rather too marked, or at least it would be unnecessary for the production of the desired effect. In both these cases, however, it is to be noted, and it is rather a curious point in regard to the effect of mouldings, that we are actually giving a greater appearance of force and solidity to the structure by *cutting away* some of the stone; the lines of light and shadow produced by modelling the edge being of more architectural value, up to a certain point, than the actual original bulk of stone, just as we saw (in Lecture I.) that greater constructive expression was given to a square column or post by removing some of its substance in order to mould it into an expressive architectural feature.

It is not always the case that the use of mouldings thus adds force to the portion in which they are worked; this depends a good deal on the situation and the manner of designing the buildings. In some cases they may be used rather to give lightness to what would otherwise appear too heavy a mass, as we saw in the case of the division of the Greek architrave (Fig. 53 *ante*) into three horizontal faces by fillets, which are in themselves a simple form of moulding. In general, however, mouldings add force to the portion of the building on which they are worked, and their especial function is to emphasise by lines of light and shadow the main lines or divisions of a building. Thus, when a building is divided up into horizontal stages, these are marked usually by bands of stone (or brick, if it is a brick building) moulded in the direction of their length, and which, as previously observed, are called in building language *string-courses;* and the moulded cornice, which forms the crowning feature of the wall, is only a final string-course, deeper and more highly elaborated, so as to dominate all the others and assert its place as the crowning member. The designing of the mouldings of the various string-courses in a building is a very important and delicate matter, demanding much more care and attention than it sometimes receives. The same profiles and members should not be repeated in different situations, which would produce an effect of monotony; besides which, various situations require various treatment; a thin and light succession of lines in one place, a deep shadow and a broad light in another; and those who are really careful with mouldings, after drawing them in full size, will have their lines reduced exactly by scale on to a rather large-scale "detail elevation," to judge the better of their effect in relation to the whole. In designing the full-sized profiles of mouldings, it is necessary to bear in mind that the only situation at which their profiles when executed become visible to the eye is at the external angles of the building, and that they meet there at an angle of 45°, and consequently, when viewed across the corner obliquely (which in most positions of the spectator they will be) their projection becomes exaggerated, and a moulding which appears right on paper will thus appear to have too much projection for its height when seen in execution.

Apart from the use of mouldings as marking horizontal divisions of the building, they are also used largely in giving effect and expression to arches over doors or windows, or to those of the arcades which form an important

portion of the construction of a building in an arcuated style. There is no better example of the use and development of mouldings than that afforded by the successive forms of moulding of the arches of mediæval buildings, in England especially, where the mouldings are perhaps finer and more effective than in the Gothic architecture of any other country. A few examples of the typical varieties of English Gothic mouldings in successive periods of the style are shown in Figs. 129 to 136; and these serve to illustrate also the manner in which the moulding, under all its changes of detail, preserves nearly to the last the idea of its origin, as the moulding of the edges of a successive series of arch-stones. In the first example, Fig. 129, which is a moulding of late Norman or Transitional date, the original form of that arch, as composed of three arches of square section one beneath another, is as obvious as possible; the roll moulding is simply worked out of the square edge of each arch, and the outline of the primitive or essential constructive form of the arch is hardly affected by it. In No. 130, which is a later example, coming pretty nearly into the period of Gothic proper, the square form is still equally discernible, though the mouldings have become more elaborated; the chief difference lying in the fact of the original round moulding being now worked with a fillet on the face and one at each side, and the interposition of a small but deeply cut hollow on either side of it, which makes a strong black shadow; the shadow being all the more effective by contrast with the lines of the fillets between it and the roll member. If the roll had merely been carried round without a break into the hollow moulding, the whole would not have been nearly so light and effective. This, which is a common form of moulding in early Gothic work, is one of the most effective in existence, though composed in a very simple manner. The deep hollow which here appears is one of the most marked characteristics of Gothic mouldings. In Fig. 131, which is a moulding of the fully developed "Early English" period, it will be seen that the hollows are more numerous, the mouldings of this period often presenting a very large series of these small deeply cut hollows, with sharp lines of light formed by the projecting portion between them. Here again it will be seen that, though the moulding has become more complicated and much less symmetrical in its parts, it still rigidly follows the original square line of the arch members. A peculiar feature of the mouldings of this period is that the true circular form in the working of the hollows is almost entirely abandoned, the hollows being sunk in various irregular forms without heed to symmetry. This irregularity of form is found frequently in the hollow mouldings of the subsequent Gothic periods, though not so generally as in the Early English period; and as the main object of the hollow is to produce a dark shadow, and the shape of it cannot possibly be accurately seen by the eye when the moulding is *in situ*, there seems reason in avoiding any special trouble in making the hollow a perfect circle: though it is possible that the eyes of the mediæval builders did detect a certain difference of effect, or at all events fancied one, in these irregularly worked hollows, and worked them in that way with a definite purpose. In Fig. 132, which is a moulding of the date of the "decorated" period, we see that the square form has been departed from in the upper member of the arch—it is shown by the dotted line, but the arrangement of the moulding is as if we had bevelled off the edge to an oblique face first, and then worked the moulding on the face of that. The rest of the moulding is still, however, arranged on the square form, and it shows the rather large hollows which became prevalent at this period, and also the return to the circular form of hollow moulding. The upper moulding on the bevel, consisting of two reversed curves of wavy contour, is a very common one in middle and later Gothic architecture (see examples 134 and 153), and is a very effective moulding when there are sufficient deep hollows to contrast with it and throw it up, as it affords a great deal of delicate gradation of light and shade. Fig. 133 shows a "late decorated" moulding which is much more irregular and wild in outline than any of the previous examples, and on first looking at it we might think that the square form from which they are still, be it remembered, actually worked in the stone—all these mouldings, whatever outline they take when complete, are worked out of so many squared stones—had been ignored; but on ruling out the squares in dotted lines we find that the fillets on each group of mouldings come up to the line, and represent a portion of the original surface of the squared stone. As we come later in time, however, there is an obvious tendency towards cutting away the stone to the oblique line, as shown in Fig. 134,

in which the projecting member at the left is only the "hood mould" or "dripstone" which projects over the arch beyond the line of the wall to throw off the rain (as its second name implies); the whole of the rest of the moulding is on the bevel. As we come to the latest period of Gothic this tendency becomes greater; Fig. 135 is an example of a late Gothic moulding, and here it will be seen that the variety and force of effect of the earlier mouldings is a good deal lost; it is a succession of similar mouldings and hollows at regular intervals and entirely on the same plane, and with none of the effective in-and-out arrangement of the earlier arch mouldings, which so precisely expressed the construction of the arch, stone under stone; on the contrary, the construction, though in a large Gothic arch of that section it would still consist of two or more series of arch stones, is nearly lost sight of, and the moulding looks as if cut out of one large stone. A further descent into ineffectiveness is shown in the kind of moulding which became common in the latest Gothic period, that of the type shown in Fig. 136, where a great portion of the moulded space is occupied by a large shallow hollow, very easily worked, and proportionately ineffective; it is what may be called a "save-trouble" moulding, the indication of a period when the style was degenerating, and the force and effectiveness of its earlier details giving way to easily-executed, scamped, and ineffective work; which, be it noticed, is ineffective in great measure from ignoring construction.

The design and character of mouldings is, in all spontaneously developed styles of architecture—*i.e.*, in all styles previous to the Classic Renaissance, considerably modified in relation to the climate under which they are to be seen and the material in which they are executed. We have in a previous lecture glanced at the peculiarly delicate character of the Greek mouldings (of which some profiles are given in Fig. 76 *ante*), and the employment in them of the most refined order of curves. But such refinement of execution could not have been adequately carried out except in a fine material like marble, and could not have been appreciated in their delicate gradations of surface and fine sharp bounding lines except in a light sunny climate, On the other hand, the bold rolls and deep round hollows characteristic of Gothic mouldings, which would have appeared too pronounced and almost coarse under the sun of Greece, are the type of mouldings required in order to produce effect in a more clouded and damp atmosphere, and to throw off the rain which pours upon them; and these bold rounded forms are moreover precisely the type of forms most suitable for execution in a comparatively coarse granular material like stone. A striking example of the influence of material may be seen on comparing with these typical forms of stone moulding the wooden moulding shown at 135A, which is the raking mould of the canopies of the splendid oak screen work in Lancaster Parish Church, and which is probably of about the same date as No. 134. Here it will be seen that instead of digging the usual round cavity, as in 134, so suitable for execution in a granular material, the shadow is got by a cavity as deep but shallower and of a pointed section, being a far easier form to cut out of wood than the rounded hollow of the mediæval stonemason.

Decorative ornament properly so called is distinct from mouldings in this, that while moulding is a shaping of the surface which is carried along continuously, decorative carving is a shaping of the surface which is varied transversely as it proceeds, either regularly or irregularly. Decorative carving is again divisible into two classes, *abstract* ornament, or such as is founded only on abstract form, and *natural* ornament, which is founded on a more or less close imitation of nature. There are early forms of ornament which are to be traced purely to the imitation of obsolete constructional details. The stone railing of the Sanchi Tope in India, for instance, [of which a drawing was shown], is nothing in the world but a reminiscence of a wooden railing with broad-headed pins to keep it together, and with these pins surviving as circular carved bosses. A curious Egyptian ornament, of which I give a drawing, is produced by the repeated forms of painted earthen jars, of the same shape but in two different tints, and painted overlapping, one vase hiding half the next one, &c. This arrangement produces a decorative effect, but it is one in which we feel that there is a false element; the form of the jar contributes nothing to the decorative effect; any other form of good lines would have done as well; it is the effect of repetition and alternation alone that was aimed at, and hence the jar form is a mere impertinence; abstract forms are all we require. It is the special character of ornament of this class that it *means* nothing; it simply deals with abstract form. There are two main kinds

of abstract ornament; geometrical, which covers a space, and alternating, which is arranged in a succession in one or more directions. As examples of geometrical ornament may be taken the well-known square pattern called the Greek fret, or sometimes the "key-pattern," a form of ornament which existed in one form or another all over the world at various times, and which, in its best form as designed and used by the Greeks, has held its own for two thousand years and more, and now seems as little likely to go out of favour as ever.* It is an ornament that seems to combine in itself all the requisites or attributes of a geometrical ornament for general application; it may be used either in a very simple form, or it is capable of a considerable amount of complexity; it is not difficult to execute; its square precise forms are essentially architectural, and seem as if they belonged naturally to building, and it fills up very evenly and fully the space in which it is introduced. Of the same order are the apparently much more complex forms of Saracenic interlacing ornament, which on analysis will be found not so complex as they appear at first sight; the multiplicity of parts in many of them is puzzling to the eye, but the key to them is very soon mastered. Both these and the Greek fret illustrate one of the requirements to give interest to ornament of this class, viz: that it should present to a certain extent a problem to the eye; it should give evidence of thought and contrivance. It is perhaps on this account that these forms continue to give pleasure and to be accepted, while such an ornament as the guilloche (Fig. 73 *ante*) is felt to be commonplace and threadbare, because its construction is so manifestly simple, and the eye takes it all in at once. The other forms of abstract ornament are those, as observed, which consist in the arrangement of repeating or contrasting forms for the sake of repetition or contrast of form. For in most ornament, and in abstract ornament more especially, repetition at equal distances is an essential element. If we draw two parallel lines and arrange broad black bars across the space at right angles to the lines, at irregular intervals, we produce nothing whatever but irregular markings; but if we arrange our bars at equal distances, we have at once a very simple form of ornament. If we modify each alternate bar in some way, either by making it shorter or thinner or in some way differing from the intermediate one, we have gone a step farther, and got a dual element—an alternation of contrasting forms. Similarly, if we arrange circles in a regularly spaced order, we have the beginning of ornament; if, after spacing them at a little distance apart, we insert a contrasting and narrower form of any kind between the circles, we have again the principle of alternation, in this case between a broad and narrow form, which is the type of alternating ornament most frequently met with. One very common example of this alternating type, the egg-and-tongue ornament of the Greeks, was shown in Fig 72 *ante*, and below it is another, the bead-and-reel ornament. This tendency to the use of two contrasted and alternating forms is found everywhere where ornament has been attempted; there are numerous examples of it in Egyptian ornament; it is seen in the beautiful Greek ornament (belonging to the "natural" type) given in Fig. 117; and I have a sketch of a necklace from the Pelew Islands, which is in the British Museum, composed of an alternating arrangement of round seeds or pods with two little flat shells strung between and alternating with them, which is exactly the Greek bead-and-reel ornament in a somewhat rougher form; the taste for this alternating arrangement being apparently innate in mankind; at all events, quite prehistoric in its origin.

Natural ornament is that which is founded on the imitation of the forms of growth in nature, but this by no means implies direct imitation of nature; on the contrary, the best ornament of this class in the world is very far from being an imitation of nature, and we may even go so far as to say that as soon as it becomes direct imitation of nature it ceases to be ornament in the true sense. For ornament implies *design*, which is a matter of thought and invention, not of copying. The reasons for this principle, which has been tacitly and intuitively adopted, at least, if not consciously, in all those which the world has agreed to recognise as the best schools of ornament, are porhaps threefold. In the first place, it is the natural desire of man, when he turns to artistic work, to create something of his own; but we are not made so that we can absolutely originate anything; we take hints from nature, and upon their basis make our own sub-creations. Then, in the materials which are available for the execution of architectural decoration, and which must be such as will be permanent and enduring, and for exterior work

* It is at present the favourite and most common ornament for the bordering of the lining of first-class railway carriages.

also such as will stand wind and weather, nothing like a satisfactory direct imitation of nature is possible, in the same way as it is with the painter's more manageable materials. Stone carving at the best can never imitate nature's vegetation; if it attempts that, it can but produce a coarse reminiscence; whereas the imitation of the principle of growth, the devising of a new design of our own carrying out in our own way a suggestion from nature, is within our power. Thirdly, it is essential that architectural ornament should be in harmony with and appear a part of the architecture; and the forms of nature, if used in an attempt at direct imitation, do not seem to belong to the world of architecture, which is a highly artificialised art; they must be architecturalised, if one may coin a word, to bring them into harmony with the building, and render them æsthetically a portion of it.

Hence it arises that in architectural ornament founded on nature we take refuge in conventional treatment of natural forms, taking the natural form as a basis or idea and transforming into an architectural decoration in an arbitrarily chosen manner. No better example of this could be found than in the Greek treatment of the acanthus leaf, which has been so successful indeed that it has placed its mark on architectural foliage ornament ever since. The sketch of the natural leaf and the conventionalised one side by side (115, 116) show better than any mere words what is meant by conventional treatment of nature in ornament. The leaf is a serrated one with deep indentations, but not regular in form. The Greek takes the fact of serration and indentation, but reduces these to an architectural symmetry. The natural leaf is thin; the Greek makes no attempt to give any corresponding appearance of tenuity to his leaf—it is a marble leaf form constituting a portion of architectural decoration—an architectural leaf; it has no occasion to simulate (which it could not in any case successfully do) the frail character of the real leaf. The leaf has a central rib with minor ribs or ridges radiating from it; this is an essential constituent of the design of the leaf, just as much as the indentations, and it is duly preserved in the architectural leaf, but in a symmetrical and conventionalised manner. The same principle is seen in the ornament from the Erechtheion, shown in Fig. 117. Here we have the system of the growth of petals from a central stem, but more highly systematised, so as to harmonise it with the architecture; the forms used are said to be, and may be, derived from the honeysuckle, but they are not allowed to retain any direct resemblance to the flower. Fig. 118, which is a piece of Gothic foliage from Wells Cathedral (on a much larger scale than the Erechtheion ornament), is interesting for comparison as exhibiting in a different style of work exactly the same idea of a conventional growth founded on natural growth; the leaf showing some of the main characteristics of a leaf, but thickened and solidified into a fitness for architectural service; the growth from a central stem again is retained as the idea, but treated with architectural symmetry. The one ornament is in marble, the other in stone; they are the work of men as remote from each other in time and place as in social and mental habits of life; but they are both first-rate examples of ornament, and different as they are, they both illustrate the same idea of the relation of decorative forms to natural suggestions.

The acanthus leaf forms, as has already been seen, the principal decorative detail of the classic capital, and its influence may be traced throughout many variations on this form of capital which have been made in Byzantine, Romanesque, and early Gothic work, the latter especially in France; as well as in further variations made in the time of the Renaissance. It is perhaps difficult to say why the capital of the column should have been selected especially as a position for the employment of decorative foliage in the first instance. Probably at the time the Corinthian capital was developed it was found that ornamental leafage afforded a convenient means of masking the awkwardness of the transition from the round shaft to the square abacus, and these forms having been used in that position with such admirable effect by the Greeks, and by the Romans working under Greek influence, became accepted as the happiest method of treating that portion of the design, succeeding generations having tacitly confessed their inability to improve upon it: for the quasi-classic capitals of the early Gothic period, though variations from, can hardly be considered as improvements on the classic capital, and the finest and most characteristic Gothic capitals depart from it so completely that they may be said to belong to another type. The foliage forms have, however, this special suitability for the capital, that they convey naturally an

idea of upward springing and spreading of the line of the column which is very suitable at the capital; otherwise, there seems no special reason why foliage forms should not also have been employed at the transition from the base to the shaft, as well as from the shaft to the capital. In Byzantine and Roman work they are, in fact, partially so employed, in order to cover and fill in the angle spaces of a square base on which the circular base mould of the column is set. In regard to the classic capital, there has been a want of enterprise and originality shown in its modern treatment; it has been accepted and copied almost slavishly, an ancient example being simply imitated over and over again; whereas it might certainly have been possible to have evolved some new treatment of it; to retain its highly conventionalised and architectural style, but to conventionalise some other leaf than the acanthus; and there is still, I think, something new to be done with it in that way, if people would take the trouble to fairly try, instead of adopting the easier method of copying. Nor need it be a rigid rule that all capitals in a building of classic manner should be precise repetitions of each other. It would be possible to give new interest to the detail of a columnar building by treating the capital with similar general outline and form and with differences of detail; an effect of which Gothic buildings afford numberless examples, but which, as far as I know, was yet to be tried in modern classic work. Of course the classic type of capital is too severely designed a form to bear the amount of variation which we see in Gothic capitals (even in the same building), but it may bear a certain amount of modification without losing its main characteristics, and would gain in interest thereby.

During the transition from classicism to mediævalism, however, we meet with a good many examples which have the appearance of experimenting with the capital, though some of these may be considered rather as corruptions of than improvements on the original form. In the Byzantine example, Fig. 119, we have the general form of the classic capital with the acanthus leaf left uncut on the edges, which can hardly be called an improvement, and seems more due to a desire to save trouble than anything else. On the abacus of this capital is placed a block with a fillet and a bevelled under side, which looks like a renewal of the Roman fallacy of placing a slice of the architrave on the top of the capital, but the Byzantine architects have left out (to their credit) the now useless architrave, frieze, and most of the cornice, leaving only what looks like a clumsy form of the crown moulding of the latter. Fig. 120 shows another curious but very illogical experiment, in which a kind of reminiscence of the Corinthian capital is placed over a nearly orthodox Ionic capital. Fig. 121 is another very characteristic Byzantine form, in which the bell of the capital is convex instead of concave,* and the abacus and necking are treated with floral ornament of their own. The decoration of the necking in this way seems a mistake; it weakens the feature and does not separate it sufficiently from the foliage of the capital. The peculiar form of angle scroll of this capital should be noticed. This is one of the thousand variations played upon the scroll or volute which first became a recognised feature in the Corinthian capital, and which was introduced to give support to the angle of the abacus. This angle scroll has been one of the playthings of architecture ever since. For a considerable period in early Gothic architecture it was reversed and turned inwards towards the body of the capital, as shown in the early Gothic capital, Fig. 122. There are Italian Renaissance examples showing a similar treatment in a more classic form of capital. This is what happens when one feature is invented, in a fortunate moment, which is seen to be a really good and useful one; it lays hold of architecture, and refuses to let go its hold however it is twisted about and disfigured. The early Gothic architects in France used it for a long time on the angles of their capitals, in variously modified forms, long after the resemblance to the foliage of the classic capital had disappeared. Then a leaf was rolled round under the angle of the French capital to take the place of the volute, and from this angle leaf, solid and heavy in substance, grew the characteristic form of foliage of the Early English Gothic capital, as shown in Fig. 126, a typical example from a Lincolnshire church, but which probably had its first origin in France. That is a form so different from the classic capital that the historical relation between them would hardly be suspected if we had not such a large train of intermediate examples in existence to illustrate it; and, what is more important to our main argument, the relation of the

* This convex Byzantine capital became the parent of a whole tribe of capitals in early French Gothic and thence in Norman and English work.

design to natural forms is very nearly the same as in Greek ornament. It is true that the capital, in its general design, partakes of the irregularity of nature, and makes no attempt at the symmetrical arrangement of Greek ornament; but otherwise it is no more an imitation of nature than the Corinthian capital, its forms being conventionalised suggestions or reminiscences of natural growths, only in a form specially suited for execution in stone, just as the finer Greek forms in Fig. 117 are specially suited for execution in marble.

The phase of experiment through which this development of the Gothic capital from the classical passed is curiously illustrated in the four small capitals figured 112-3-4-5, which are all close to each other in a wall arcade just inside the west door of Peterborough Cathedral. These must all have been worked at the same time, and they look like the deliberate trying of experiments with different forms of capital. Fig. 125 is nearly the type of capital shown in Fig. 126, except that the lines of the leaf stems are straighter and more abrupt; they have not acquired the life-like curves of the rather later example (126), in which the leaf forms seem as if the bell of the capital, like Aaron's rod, had budded from an inherent impulse. Later in the Gothic style the foliage lost this appearance of springing inevitably out of the bell of the capital, and assumed the aspect of being bound round it independently, with much inferior architectural effect.

Next to the capital with its acanthus or other leaf, perhaps the most important element in natural ornament has been the scroll. The scroll indeed is not itself a natural but an abstract form; but the arrangement of natural ornament on the scroll line enables us to carry it on with an appearance of growth and freedom, and with an effective contrast to the horizontal lines of the building. The first and most essential quality in a scroll design is that its curves should be cleanly drawn and designed and they should all be tangents to the straight portions from which they spring. No amount of richness and effectiveness in leafage detail will atone for any initial defect in the curvature of the lines: and this is why the Roman scroll ornament, rich and broad in detail as it often is, nearly always looks common and awkward in comparison with Greek scroll design. In Roman work the scroll is not sufficiently conventionalised and geometrised; it is left to assume something of the accidental breaking and irregularity of line which a real branch might assume if bent into a scroll form; and this fatal error destroys all its beauty, and reduces it to a kind of cabbage-garden ornament. In Greek work the scroll is drawn with geometrical precision and in clean sharp lines, as shown on the lower part of Fig. 117, for instance; and in any cases where leafage forms a more important portion of the scroll than this, the precision of the curve and the clear character of the lines is never lost. The same tendency to severe line may be seen in the Indian example (Fig. 128), which, like a good deal of work found in India, shows manifest traces of Greek influence. In the best period of Gothic work (as in Fig. 118) the clean character of the curve is also preserved, as well as in the best Italian Renaissance ornament. When we come to late English Renaissance, we find, as in Roman work, broken and crippled curves, and straggling and ragged festoons of flowers, doing duty as "ornament;" and in the later French Renaissance of Louis XIV. date, so far has the true idea of scroll design been lost sight of, that we find one of the main features of Louis Quatorze and Louis Quinze ornament consists in the introduction of a number of short portions of scrolls which only touch either on the convex of their curves, and which have lost all appearance of unity or continuity of design, and form merely a bundle of patchwork unworthy of the name of ornament. Architecture at her best will have nothing to say to these crippled and ungeometrical curves; they are not ornament, but only bungling. A curious example of the defect of this bad drawing of the curve is shown in an example of Indian ornament in low relief (Fig. 127), from a square pillar in the Indian Museum at South Kensington. This is an odd mixture of conventionalism and naturalism. The separate flowers are conventional, and very well treated; the lines of the stems are only partially conventional, and are laid out in badly designed curves, neither natural nor geometrical, but with a kind of pretence of being either or both. Hence what might have been a good piece of ornament has been spoiled. Curves are exacting things; they demand respectful treatment; and if laid out at all as a portion of ornamental design, of which they form a most effective element, they must be laid out truly and geometrically, and if neglected in this respect they will amply revenge themselves on the designer.

But architectural ornament has to be considered not only in itself, but in relation to the

building. When we regard ornament in this relative sense we shall see that it may be considered under two heads, *surface* ornament and *functional* ornament: the former being that which is employed merely to cover a surface which would otherwise be a bare space, and give it more interest; the latter being employed to give an emphasis to some portion of the building which has a special function in the design. Thus the capital is functional ornament; so is the fluting of the columns, the moulding of the bases, or the ornament frequently introduced into one or two of the arch mouldings in Gothic architecture. We find this use of ornament illustrated equally well in other objects besides architectural ones; for instance, we may take as an example an Egyptian bottle, which is seen in one of the wall paintings in the British Museum, in which the body is a terra-cotta brown with a thin green spiral line round it, and the neck is white with black rings. Here there is functional ornament distinguishing the neck of the bottle from the body; a very early example of a method of using ornament to give special expression, which has been used in a thousand different ways since. Surface ornament may be and often is derived from the arrangement of constructional materials; for instance, there are some drawings here of Saracenic ornament, one of which is derived simply from the interlocking arrangement of bricks of a certain shape and of three different colours; another is formed by the arrangement of tiles, which must be arranged on some system and may as well be arranged in a decorative manner. Then again surface ornament may be derived also from geometrical or from natural forms, arranged so as to form a continuous device or *diaper* over a surface, without in any way affecting the architectural expression or design, but merely giving something to take the eye and to break up the surface, where otherwise it would be a blank. For this use of ornament simple forms which are effective by repetition are the best; it is not worth while to expend forms of higher elaboration merely on the filling up of blank spaces, unless the spaces are such as to furnish an opportunity for painting in the intellectual sense, and that is another art; not a part of architecture, but a separate art to which architecture is the framework.

There is some relation to be observed between the nature of the ornament and that of the surface on which it is executed. For instance, in the functional ornament which often decorated the separate mouldings of the Greek cornice, there was generally some relation or resemblance between the leading lines of the ornament and the section of the surface on which it is executed. Thus a Greek ornament such as that at Fig. 117 would more generally have been executed on a delicately curved surface, convex below and concave above, somewhat resembling the lines of the narrower alternating member of that ornament. The egg-and-tongue ornament (Fig. 72 *ante*) is usually executed on a member with a convex curve turned downwards, somewhat like the curve of the outer side of the "egg" member of the ornament. The Greek fret or key-pattern again, to which we have referred, is never in any one instance that I know of executed except on a flat surface, with which alone it is in accord; on any curved surface its severe square lines would be out of keeping with the position, and would suffer a distortion which would interfere with the essential character of the ornament.

Another thing to be noted in regard to surface ornament is that it must never in any case be so designed as to conceal or contradict the nature of the surface on which it is placed. As an example of what is meant, a drawing of a Roman mosaic pavement design is exhibited, in which the pattern, a variety of the Greek fret, is made, by dint of shading and a perspective arrangement of the lines, to appear as if the bars composing the pattern were standing up on their edges, thus giving the floor, which is really a flat surface intended for walking on, the appearance of a kind of grid-iron. This is a flagrant example of bad taste; but blunders of the same kind, though not often so bad as this, are not infrequent in wall and floor decorations.

In ornament derived from nature, whether functional or superficial, it is exceedingly important that consistency of style should be preserved, especially in regard to the degree of approach to nature which is admitted. In this latter respect a great deal of the ornament of the school of the Adams, which has come so much into fashion lately, is exceedingly faulty; it is not uncommon to find combinations in which there is a scroll, perhaps, of conventional acanthus leaves, with a spray of purely naturalistic foliage springing from it; a mingling of contrary *motifs* which is absolutely at variance with any idea of style at all. Still worse is the mingling of natural forms with artificial ones, of which there has been too much in Renaissance as well as in

modern French work; and worst of all, perhaps, the fabrication of ornament by the imitation of artificial objects alone. This is, wherever and however it is done, the worst and most vulgar form of architectural ornament; there are degrees of badness in it, no doubt; it may consist of artificial objects rather effectively grouped into a kind of decorative bundle, as is the case in some French work and in some of the ornament of the school in which Grinling Gibbons was prominent; or it may be, as in a well-known Roman frieze, a mere collocation of utensils carved without even the pretence of arrangeing them in a semi-decorative manner; which is about the lowest barbarism to which architectural ornament can descend.

The question has been discussed sometimes, how far ornament can express any meaning or sentiment. As a general rule I think it may be said that it can rarely do this without at the same time ceasing to be ornament in the true sense at all; ornament being essentially something created for the sake of beauty. There has been a certain practical meaning in some ornament, as in the ox-head (or skull), and wreaths and pateræ between, which used to be sculptured often on the frieze of a Roman temple, and which symbolised the sacrifices which went on within the temple. This has been imitated in modern architecture without any excuse or meaning at all, these objects not having the same signification for us; the real parallel would be if we sculptured the exterior of a law-court with bas-reliefs of judges' wigs with gowns festooned between them, or the exterior of a hospital with an alternating ornament of bottles and bandages; we should then be doing the same thing that the Romans did with their ox-head and garland friezes. There have occasionally been fairly successful attempts at giving a half-symbolical meaning to architectural ornament; M. Garnier has done this, for instance, in some of the capitals in the Paris Opera House; in one, of which a drawing is shown, the centre of the capital is occupied by a very conventional suggestion of a lyre, which spreads out at each side into members which distinctly suggest wings; it is very cleverly done; there is no imitation, but just the hint given to the mind of an idea; but it is only when done in this delicate and reticent manner that such treatment can be a success. This reminds one of that famous Egyptian example, the winged globe, which is a grand suggestion no doubt, but in the way it is generally used in Egyptian architecture it is perhaps more properly termed a symbol than an ornament.

While speaking of architectural detail, it may be of interest to those who have no practical knowledge of architecture to give some idea of the manner in which the detail of a building is shown and worked out in actual practice. To this end I have given a reduction of an elevation which happened to be conveniently to hand (Fig. 137), which will do as well as anything else to illustrate the subject, and shown some of the details to a larger scale along with it. Taking the right wing of the building, there are various horizontal divisions on it marked out by what are mouldings, (A, B, C, &c.), but which on the elevation necessarily appear only as groups of lines, indicating the edges of the various members of the mouldings. One of the first things in working out the details of a building is to design the actual profiles of these mouldings, which in practice would be drawn out full size, but here, for considerations of space, they are shown only on a good deal larger scale, in Figs. 139, 140, 141, &c.; the mouldings being identified by the same letters which are attached to them on the elevation. This process would be gone through for every such set of lines shown on the elevation. The cornice, D, is also shown, a small part of it, in elevation, in order to show the design of the carved ornament on the frieze, which cannot be expressed by a section. Similarly, in Figs. 144, 145, the balustrade, cornice, and pannelling at G and F on the elevation, are shown in detail, in section, and with the distance of the balusters shown in elevation. In drawing details of such portions as doors and windows, it is not necessary to draw the whole out full size or to a larger scale. In Figs. 146, 147, 148, for instance, the whole of the detail of the centre entrance is given. Fig. 146 gives the section of the mouldings of the arch, and 147 the plan of the jamb below it, with its three shafts. Fig. 148 is an elevation of these portions, drawn as if standing within the centre of the doorway and looking towards the side of it. Part of the ornament at the point L on Fig. 146 is shewn in elevation at L, Fig. 148. The caps and bases of the shafts are shown; the intermediate length of the shaft it is only necessary to mark in figures. In actual practice, the whole door, or its half elevation, half plan (the two sides being alike), and section, would probably be drawn out to a larger scale than the general elevation (say half an inch to a

foot, or an inch to a foot)* for greater accuracy in proportioning the parts, and the details shown here would be drawn full size. A similar process would be gone through with other portions; for example, the first floor windows in the right wing, or rather in this case the piers between them, the detail of which is shown in Fig. 150; the plan at the top, and below it the detail of the upper portion, the little bit of ornamental band in the centre, and the base; the portions between being figured; a section would also be required, which there is not space to show. Every feature of the *façade* would have to be drawn out and detailed in the same manner; and when it is considered that the detailing of such a front as this would in itself involve about fifty details, mostly full size, not to speak of the other three faces and the multiplicity (probably) of interior details, you will probably recognise that the designing of a large building for actual execution is a somewhat more complicated business than the majority of persons outside the profession of architecture are aware of.

Apart from the decorative detail which forms an integral portion of the building, there is a separate class of what may be called *applied decoration*, consisting of work which is not built up with the building, but attached to its surfaces afterwards. Of these forms of decoration the most important and valuable, perhaps, and the most distinctly architectural in character, is mosaic. I call it especially architectural because, being formed by the collocation of innumerable small pieces, there is a kind of character of miniature building about it which assimilates it with the main building. Mosaic cannot be used in positions too near the eye, as a certain distance is required to blend the cubes of which it is composed together, and it is best put together and has the best effect on a concave surface, where it gets varied lights upon it, though it can be used with effect on a flat wall and (of course) on a floor. It is rarely used on convex surfaces, owing partly to the greater difficulty of fixing it in such a position, though it can be done; and mosaic has even been used in ancient, though not in modern, architecture, as a decorative covering to the cylindrical surface of a column, a treatment of which Mr. Poynter has given a representation in his picture, "Diadumene." Marble inlay, a beautiful system of decoration, is a kind of mosaic on a larger scale, put on with larger pieces, and most suitable for a flat surface, though it has been sometimes employed with effect in such positions as the soffits of arches. A method of forming mural pictures of a very permanent kind by an inlay of coloured marbles, in large masses, was invented by Baron Triqueti, and some examples are (or were) to be seen at University College, Gower-street; it has a good effect, and is a form of permanent and durable decoration which perhaps merited more attention than it has received. Tiles form another branch of applied decoration, differing from mosaic in this, that each tile is susceptible of bearing a distinct design in itself, which may either be complete in itself and form a repetition pattern by the juxtaposition of the tiles, or may be so arranged that several tiles may work together into a larger repeating pattern. Another form of applied decoration which was a good deal used in Italy in the Renaissance period and to which attention has lately been directed in this country, is *sgraffito*, which is formed by laying a coat of (generally) black plaster of the usual thickness (but any fairly dark tint will do), and laying on this a very thin coat of white plaster, in which, while still soft, a design is drawn by removing the white where required, leaving a design either black on a white ground or white on a black one. This has the merit of being a form of applied decoration which is cheap, easy to work, and under certain circumstances very effective; but it is not very durable, and in towns is apt to lose a good deal of its effect through discolouration before very long.

In conclusion, passing from the consideration of architecture as the designing and decorating of a building regarded by itself, and apart from its surroundings, there is a wider view to be taken of architecture in cities, which are a collection of buildings forming an architectural group or a series of architectural groups in themselves. In these days, when cities are not founded all at once by the will and command of some omnipotent ruler, but grow up insensibly as a gradual agglomeration of buildings, the disposition of which is defined far too much by accidents of site, we have no chance of doing what would be the grandest form of architectural design that could be undertaken—the designing,

* The general plans and elevations of a building are in England usually drawn to a scale of eight feet to an inch for buildings of average size, or ten feet to an inch for very large buildings; for comparatively small buildings four feet to an inch is sometimes used: this used to be the favourite scale, but it is inconveniently large for anything above the size of a small house.

namely, of a whole city so as to give the greatest effect of climax to its larger buildings, the finest combination of convenience with picturesqueness in its streets. But this desire for architectural effect in the disposition and grouping of buildings is never entirely dormant. In the life of every city there occurs from time to time a crisis in its development; a time when the old buildings are found deficient and are to be rebuilt on a grander scale, or when this or that quarter of the city is too crowded and a new street is to be opened out; occasions when there is usually some attempt, or at least the pretext of an attempt, to take the opportunity of getting a new and finer effect of architectural combination. In this country the mischief is that these opportunities are either neglected or taken in hand in a faint-hearted half-and-half manner, and, if we may judge from the results, by persons who either do not care about or do not understand the matter. London is in itself a whole history of lost and wasted opportunities in this respect; in many cases arising from a poor and short-sighted spirit of economy. There was the greatest opportunity that an old city ever had, after the burning of London, and Wren had a grand plan for laying out anew the burned city; but he was not allowed to carry it out, and we suffer from the parsimony of the Government of his day, as future generations will suffer for our economies and mistakes. A great many new streets are lined with buildings irrespective of any general consideration of architectural effect, and thus we have perpetuated such dreary and soul-oppressing avenues as Victoria-street and Cromwell-road, the very look of which seems enough to frighten away any one who cares for beauty from wishing to live in them. In matters of detail we are, in London, most curiously neglectful of what the French, who are very attentive to these points, call the *emplacement* of buildings. It would have been quite easy, for instance, to have placed the Albert Memorial on the axis of the Albert Hall, instead of putting it just so much out as to look as if it had been meant to be central, but had been set out wrong by some bungling person. The removal of the Constitutional-hill arch recently is another example. I doubt if there was any practical necessity for removing it at all; the way would have been to have carried an inclined plane road from opposite the foot of Park-lane, running *under* the bend of Constitution-hill into Grosvenor-place. But whatever may be thought of that, the manner in which this so-called improvement has been carried out shows an utter want of architectural perception. The arch as it formerly stood made, standing parallel with Apsley House and the Hyde-park entrance gates, a kind of monumental entrance into London from the Knightsbridge-road. It is now facing nothing, grouping with nothing—stands as if it had been built by accident; and for the *place* which has been thus opened nothing better seems to have occurred to the official architectural mind of the Office of Works than to let the road lines cut the space up irregularly into three shoulder-of-mutton slices. The plan is that of a surveyor's clerk, not of an architect. We are worse off even with our other official authority, the Metropolitan Board of Works. They would have liked to have ruined the portico of St. Martin's to widen a small bit of road, if the rector had not had the sense to stand in their way; they would like to pull down St. Mary-le-Strand, the central architectural ornament of that part of London: it is generally believed that they would pull down St. Paul's if they could make a new street over the site which would be two minutes shorter to somewhere than the road round it. We will spend no proportionate sums over our great buildings. When money is asked for such a building as a War-office, instead of there being any desire to do it in a way worthy of a great country, and such as would be a delight and pride to future generations, the cry in Parliament is nothing but economy, economy! and the thing is to be patched up in the cheapest way it can be done, and with no regard to architectural grandeur; while a little kingdom like Belgium, as if to shame us, has spent about a million on Law Courts for the sake of doing a grand thing, and produced a building which is one of the architectural achievements of the age. This growing indifference and, I should venture to say, stupidity about the architectural treatment of a great city, is a sign possibly of something more than architectural indifference: it is an indifference to the greatness and honour of the country. Periods of great architecture have usually been periods of great national aspiration of one kind or another; and when a nation is indifferent to its public architecture it is only too probable that it is in a "don't care" way in every respect, that it is going down hill, and, as Matthew Arnold says,

"Letting
Slowly die out of its life,
Glory, and genius, and joy."

Leaving the city, the relation of architecture to the landscape in which it stands takes us finally to the last and widest view of the subject of architectural design. There are few provinces of human labour and invention which, if we follow them out to their final consequences, will not lead us into further and more extended relations with the world around us than we dreamed of at starting; and architecture is no exception. We begin with stones and beams, with the placing of a lintel or the turning of an arch, and we end with finding our work a part of nature's scenery, lighted by her passing gleams, darkened by her cloud-shadows, or drenched with her rain and storm. The consideration of the effect which the building may have on the landscape, and how the site will affect the building, is one of the most interesting problems in connection with architecture, quite worth a lecture in itself, and far too large to do more than touch upon now: but it is one very much neglected. What is chiefly, I think, to be aimed at in such a case is harmony of tone with contrast of line. Harmony of tone is best secured by using as far as possible the natural building materials of the district, a thing which I think should always be aimed at where it is possible: that is to say, where there are any building materials fit to use. And why contrast of line? Well, partly because you cannot compete with nature; if you are to build among hills, it is no use trying to overtop them or come into competition with them; build solid and level by contrast with them. Illustrations of this feeling for contrast may be found both in actual buildings and scenery and in the works of great landscape painters. Among the mediæval churches the great spire-building districts are in the flat countries, such as Lincolnshire, where the spire derives additional value by contrast with the level lines of the landscape from which it rises, and over which it is seen for many miles. Few great spires have been built among hills. The Greeks placed many of their temples, especially the Doric temples with their square masses and long level lines, among broken and rocky scenery, if not from the conscious intention of contrast, at least with an intuitive feeling for it. Mr. Herbert Spencer, indeed, in an essay upon this subject, has maintained that a picture of a Greek temple amid rocky scenery has an appearance of incongruity and is not truly picturesque; but it is clear the Greeks who built the temples were not of this mind. Their greatest Doric temple, the Parthenon, is seated on the top of the rocky crag of the Acropolis. A lofty spire-like building would be out of place in such a situation. There is a striking design of Turner's (among the *Liber Studiorum* I think) showing the spire of Salisbury Cathedral rising across the horizontal line of a long low hill which actually exists near Salisbury (Turner would have had no scruple about inserting the hill if it had not been there, but as a matter of fact it is there), with the obvious intention of increasing the "value" of the spire by contrast with the horizontal line of the ridge of the hill. I give a sketch of an actual scene in which a house which is but an ordinary piece of architecture in itself is made to give a special accent and character to the scene, by being placed on the very point where the landscape seems to require such a feature, so that the landscape and the building both gain in effect by the combination.* Two sketches of old Scotch castles (from Billings's well-known work on the subject) serve to illustrate the harmony of massive square buildings with rocky landscape. In one case the massive block of the castle rises straight off a level lawn, and appears quite out of keeping with its situation. The other, the grand castle of Borthwick, with its double towers, stands on the highest point of a rocky eminence, and seems exactly the building for the situation. A fine example of Turner's illustrates a painter's idea on the subject in rather a different manner. This is the fine picture of Conway Castle, now (January) in the Grosvenor Gallery. Here the castle stands as a dark square mass in the middle distance of a flat stretch of land. Turner evidently felt that in this situation the castle, which it was his object to emphasise, would not in itself tell sufficiently; accordingly he has built up behind it a rampart of clouds in square masses repeating to a certain extent the lines of the building, and thus given it a mass and grandeur of effect which, owing to its position, it would not otherwise have had. Perhaps one of the most interesting and fascinating tasks which the architect could have, but which for financial reasons he cannot hope often to have, is when, having built a great mansion in the midst of a fine landscape, we

* This and the other sketches referred to were placed on the walls.

can proceed gradually to connect it architecturally with the landscape itself, by a treatment of the gardens and immediate surroundings with architectual formality in the neighbourhood of the house, and gradually decreasing the symmetrical and architectural character of the surroundings until the design, as it were, resolves itself into and blends with the surrounding landscape. This may be called "landscape gardening;" it is unforfortunate that it is too often no more than this; but it is a task entirely within the proper scope of architecture, and when successfully carried out it gives the last touch of interest to the architectural design, which is not to be a blot or an intruder in the landscape, but rather to give it the higher interest arising from the expression of human life and human intellect.

Casts of classic work, in illustration of the lecture, were lent by Messrs. Jackson and Sons, 49, Rathbone-place, Oxford-street; and casts of Gothic work by Messrs. Farmer and Brindley, Westminster-bridge-road.

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.

By W. H. Preece, F.R.S.

Lecture I.—Delivered 4th January, 1888.

I appear before you to give a short course of two lectures on the application of electricity to lighting and working. To-night I shall confine my attention entirely to lighting, and if we succeed in getting through our subject, we shall devote ourselves next Wednesday to the application of electricity for working tramways, to the transmission of power for various purposes, and generally to working.

Many people imagine the electric light to be a cold light. It is a delusion. It is called a cold light because in many of its forms it gives what we may call a cheerless light; it has not got the warmth, the comfortable look, of other artificial means of illumination.

The electric light owes its existence to the intense heat that the electric current produces, and heat lies at the root of every system of artificial illumination. For instance, suppose we take a common match and light it, we light it simply because by the friction of the two surfaces together we generate heat, the heat burns the substance of which the match is made. We are able to light a common candle because we have applied heat to the wick, the heat liquefies the wax of which the candle is made, the wax is decomposed, it combines with the oxygen of the air, intense heat is produced at that point, carbon is consumed, and the consequence is light. So with all our various modes of artificial illumination. Gas, as you are well aware, produces intense heat, and the result of that heat is light. There are various ways in which gas is applied to produce heat and the necessary consequence —light. Here is a Sellon gas-burner, in which the combustion of gas raises the temperature of a fine platinum cap, and the result is, as you see, a very beautiful light. In one lamp we have a cap or mantle, in the other case there is merely a flat disc gauze of platinum. The combustion of the gas produces intense heat, which raises the network to a very high state of temperature, though in the present case the light is not so good as it should be, probably through the pressure in the supply main not being sufficiently great.

In another case we have a gas jet surrounded with a network, of some vegetable matter, linen or cambric, steeped in a solution of salts of zirconium, and a few other rare earths, and the intense heat of the gas causes a very high temperature, and, as you see, a very brilliant effect is produced.

You will see from this that in all cases of artificial illumination bodies have to be raised to a high state of temperature. I hold in my hand a piece of magnesium wire, it is really flat magnesium tape, but it is called wire. If I heat that you will observe that a very brilliant light is produced, due to the very high temperature at which it burns. Now, if I take a lump of coal and heat it—it requires to be raised to a certain temperature before the oxygen is directed upon it—and subject it to a jet of oxygen, you will see that it burns with very much more intense light than you are accustomed to in the ordinary fire. If I take a piece of iron wire and place it in a jar of oxygen, you see what a very brilliant effect the combination of oxygen and iron produces through the iron being raised to a very high temperature.

I have now shown you that in order to produce light we must, by some means or other, raise the temperature of a body. But the high temperature that we have to deal with is not that produced by the combination of the oxygen

of the air and carbon, and other bodies such as I have shown you, but it is produced by the aid of the electric current. In all these cases the result of the combustion you have seen has been to remove oxygen from the air, but now I want to show you how a body can be raised to a high state of temperature without combustion of any kind. In front of me I have a fine platinum wire. In my hand I hold a wire that is in connection with a battery upstairs, the other wire in connection with the battery is attached to the far end of the fine platinum wire; now, when I make contact with the near end of the platinum wire, you observe that the wire is raised to redness, its temperature is high, and as I reduce the length of the platinum wire it gets brighter and brighter, the amount of electricity passing through it is greater and greater, and presently the wire is fused. I should have pointed out that as the quantity of heat generated in a wire increases, so does the colour of the light. When heat is applied to a body, that body is first warmed, then it gets gradually hotter and hotter, until it becomes red hot, and the first colour that appears is always red. The temperature is further raised, and the body assumes the colour of orange, then at a little higher temperature it appears yellow, and so the different colours of the rainbow are perceived according to the different temperatures to which the body tested with is raised. And now I want to show you the most intense form in which heat can be produced on this earth. There is no hotter object that we can obtain than that of the electric arc. I will try and produce this arc. You observe that when I bring these two pieces of carbon together a current of electricity passes between them, and the passage of the current of electricity between them creates such an intense temperature that a brilliant white light, as you see, is produced. Incandescent particles of carbon pass beween the two points, forming a sort of bridge or arch, which is called the electric arc. But the temperature of this arc is, as I said before, the highest temperature that we can produce; it has been measured, and is found to be 8,500° Fahr. That is a temperature that can hardly be conceived; the melting point of iron is only about 1,200° Fhr., the melting point of platinum, which is one of the most refractory metals we have, is about 3,000 Fahr.; but here in the arc we have the intense temperature that nothing can withstand, equal to 8,500° Fahr. The colour is really due to the combustion that takes place between the materials forming the arc. I have just used two pieces of carbon, but I will now try other materials—copper, iron, and zinc. You will see a difference in the colour of the light, due to the fact that metal is burned in the arc instead of carbon. Every metal has its own distinct and particular colour, and the presence of the different metals can be detected by the character of the small arcs produced.

I have shown you that we have two modes of producing intense heat, and therefore light, by electricity. I want now to show you how we produce electricity. The first essential for the production of electricity with a hand machine like this is a good dinner. The energy provided by beef or mutton enables the operator to turn the big wheel of the machine, whence motion is transmitted to the apparatus for producing the electricity. This machine when rotated causes a coil of copper wire to be whirled in a magnetic field, and that rotation of the coil in a magnetic field converts the energy derived from the grass and from the mutton through the machine into electric currents; those electric currents flow through wires that are under the table, they will appear in the two wires I hold in my hand, and will, I hope, reappear in the little glow-lamps I have before me in the shape of heat and then of light when I attach the wires. The light of the glow-lamp is of just the same form of energy as that which passed from the sun to the earth, and, by beginning backwards from the lamps we have light, heat, electric currents, mechanical motion, food or fuel in the shape of mutton, grass on the South Downs, to the sun. Whichever way it is taken you will find there is direct action between the sun and the glow-lamp. The lamps are now burning, and you see that we are able to produce electricity to our hearts' content. Downstairs there is a gas-engine; the gas-engine is at work; the gas-engine works because the gas supplies energy which, stored up in the bowels of the earth in the form of coal for ages and ages, has been extracted; it has been converted into gas at the large gas works down the River Thames, it has been brought up here, it is burned in the gas-engine, and produces energy in the gas-engine exactly in the same way as the mutton or beef produced energy just now. There is a dynamo downstairs exactly like the dynamo that we have upon the platform, and the current that is produced is exactly as the current we just obtained, and is sending electricity through

all the lamps in this room. The currents of electricity passing through the lamps are producing intense heat, the heat is producing the incandescence of a fine carbon filament, such as I will show you directly, and the consequence is that we are now being lighted in this room by the energy that unmistakeably and undisputably arrived on this earth millions of years ago in the form of sunshine.

We can store up the energy in batteries. I shall show you to-night two or three different forms of battery. Here is what is called a primary battery. The only difference between a primary battery and a secondary battery is this; that a primary battery consists of chemical elements that at once combine and produce electricity by combustion, whereas a secondary battery involves some anterior electrical action, which prepares the surfaces of two bodies to put them in exactly the same condition as a primary battery. Here is a primary battery known as the Schanschieff, which is charged with a solution of sulphate of mercury, and into that sulphate of mercury we will dip plates of zinc and plates of carbon. Zinc has a greater affinity for the sulphuric acid of the sulphate of mercury than mercury has; the sulphuric acid will at once combine with the zinc, it will burn the zinc just as the gas burned just now, but instead of burning with heat and light in the battery it burns in the form of electricity, which appears in the glow-lamps attached. You see that the moment the zinc and carbons are placed in the cell electricity is produced, and the lamp is lighted. The form of battery from which we are drawing our electricity to-night is the accumulator, or the storage or secondary battery. The secondary battery simply consists of plates or "grids," as they are called, one filled with litharge, and the other with red lead; the one becomes pure lead, the other becomes peroxide of lead; the plates are combined in this form, and then placed in a glass cell, and upstairs there are 52 of these E.P.S. cells, which have been charged all day long by the gas-engine of which I spoke, and which now contain a store of electricity that I shall make considerable use of to-night before I finish.

I showed you the form of electric light which we call the arc, and I have here to-night two or three different forms of arc lamps, which I will show in action. But I want you to see this arc light for yourselves, and I want you to feel, as I feel, that in all nature there is nothing more wonderful and nothing more beautiful than the action of electric currents in the arc. The light is, as I attempted to show you, the very same light that came from the sun. I can show you that it is of the same character as the light of the sun, and in the lantern on the table there is an arc lamp the light of which we will throw on the paper before me in the form of a spectrum. There you see the spectrum in all its purity; the spectrum from the sun is no purer as regards light than what you now see. There you see all the colours of the rainbow, and I had intended, if it were possible, to show you in the first experiment in which we raised platinum wire to incandescence, that the first colour would be the red, then the orange, then the yellow, then the green, then the blue, then the indigo, and lastly the violet. Beyond the violet there are rays of light which we cannot see; they are the rays that produce the photographic pictures, and, had time permitted it, we would probably have taken to-night a picture by means of the arc lamps, but it requires a long time to do so, and it really is no more interesting than an ordinary photographic picture. There are all the different colours of the rainbow. Those who are anxious to remember the order of the colours can very easily do so if they will remember this simple sentence, "Read over your good book in verse." The first letter of each word in that sentence gives the first letter of the colour in the order of the spectrum. It would be a very good thing if some of our artists were to study and remember the colours of the rainbow, for it is an extremely rare thing indeed to find a picture with the colours of the rainbow properly depicted, sometimes they are upside down, sometimes they are mixed, and if you discuss the fact with an artist, he will say, "I do not care about your science. I simply paint my own impressions."

I will now show you the arc in another form. We are to-night connected in this room—I have told you there is a gas-engine down stairs; there are also secondary batteries upstairs—but we are in connection with the Grosvenor Gallery in Bond-street. The Grosvenor Gallery has a central station where a very large dynamo is at work, from which electricity is supplied to different parts of London; many thousand lamps are fed, in a great many clubs, theatres, and private houses; they are all lit up by the currents generated underneath the Grosvenor Gallery. The Grosvenor Gallery Company, through their engineer, Mr. Ferranti, have very kindly

undertaken to supply us to-night with a current. The current is supposed to be a very dangerous one; in reality it is not; there is no electric current that has ever been produced that is one-tenth as dangerous as a steam boiler, and all these currents, however immense they may be, are very simply controlled, and very easily brought within the region of safety. There is no doubt that with the apparatus that is now being handled in this room, if anybody were deliberately to put one wire in his mouth, and the other in his hand, he would have the funeral service performed over him in two or three days; but those who know what they are about no more handle electric light wires carelessly than they put their hands in a furnace or their noses in boiling water. We acquire experience by practice, and we know by this time pretty well how to deal with electric currents. Now you see in the lower arrangement there that safety catches are being put in, which render any accident quite impossible. Passing through each of those boxes there is what is called a "cut out" safety fuse, or safety valve, and should, from any accident, anything go wrong in this theatre, or in any way with the system outside the theatre, the safety fuses would burst, and would so remove all danger from inside. The switch has now been turned, and by it the current from the Grosvenor Gallery has been brought within our reach. You see an arc light produced by it, and you see how intensely bright and brilliant that light is. I do not want you so much to see that light itself, but I want you to see its projection, or picture, and if Mr. Wickham will kindly direct it on to that white paper, at the end of the room furthest from the table, you will see a picture of the carbons which are now emitting that intense and brilliant light. You will see that between what appears to you as the top carbon (but which is in reality the bottom carbon of the two) and the bottom one there is playing, apparently, a shower of minute fragments of something, but which are in reality innumerable minute flashes of lightning, there is a constant uninterrupted shower of electric shocks passing, that produce that intense brilliancy, and that very bright appearance. There is intense commotion, a terrible surging about of matter in a molten condition. Well, that arc that you see is produced by the currents from the Grosvenor Gallery. They are alternating currents of electricity, currents that are constantly and suddenly circulating backwards and forwards. The arc that we have at this other end of the room is a direct current one, and it is now projected on to another sheet of paper, where you see a different form of arc altogether. This arc is produced by the direct current from a battery. You will see the form is quite different from that in the alternate current arc. You heard a peculiar hissing sound just now; that is a peculiar phenomenon in arc lamps that has attracted a good deal of attention from physicists, but nobody has yet arrived at a satisfactory conclusion as to the cause. The lamp sometimes sings and sometimes hisses, and while thus behaving it produces an intense and variable inverse electromotive force, that has to be overcome before the current can produce a steady and silent arc. You will notice in the upper carbon of this form of lamp a kind of cup, or "crater." The lower carbon forms a kind of point—a raised surface, and between the two there is on the projection that which appears as a glow, but which in reality has very intense heat, reaching, as I told you, a temperature of 8,500° Fahr. In those two projections you have, I think, within my experience for the first time, shown in public an alternate current arc and a direct current arc at the same time, so that you are really able to see what I do not think most people have seen before.

There are a great many different arc lamps. I have not time to bring before you all the various lamps that I might have secured for your inspection. There is the Brush lamp, that for a long time lit up the streets of our City, and I sincerely hope very soon is going to light up the City again. There was the Jablochkoff lamp, that lighted up our Thames-embankment, and which can be seen, on going down the Strand, at the Tivoli Restaurant, not far from here. The offices of the *Daily Telegraph*, in Fleet-street, and many other places, are lighted up by different lamps, many of them excellent. Our experience of the last two or three years at the exhibitions have taught us that there are a great many different kinds of arc lamps, but all these arc lamps are lamps so constructed that they cause the pair of carbons to be fed, to be kept together, as they consume, at the same rate as they do consume. The mechanism is of great delicacy, it acts with great promptitude, and the one that we have here to-night is one of the last and one of the best; it is known as the Brockie-Pell lamp. The lamp now at work is a Brockie-Pell, and for those who are interested, a diagram representing it is upon the wall, and its operation I

shall be very happy to explain after the lecture; it feeds with great rapidity, with great convenience, and is one of the steadiest lamps we have.

There are objections to the arc light; it is extremely dazzling and irritating to the eye. Although the arc lamps we have here to-night are of the very best of their kind, and are certainly almost steady, still they have little irregularities in their action, and worst of all, they throw intense shadows. The light from them is not very well diffused, still the light is very brilliant, and it raises the envy of a good many people. For instance, the Brush Company were once establishing a light in the neighbourhood of Cork, and an Irish farmer was remarkably struck by the appearance and the steadiness of the light, so he came to the engineer in charge and asked him, as a great favour, if he could kindly tell him where he got his oil from.

I must now go from this to the next branch, the glow-lamp, the lamp that is burning so steadily and so nicely above us. For this lamp we do not use platinum, such as I heated before you just now, but we use carbon, so fine that although I have probably one hundred or more in my hand, they feel no heavier than a feather. These extremely fine filaments of carbon are made, with very great care, from cotton. I cannot show you the whole operation of making carbons and some of the preliminary operations connected with the making of the lamp; but owing to the kindness of the Anglo-American Brush Company, their manager, Mr. Sillar, is here to-night, and we shall have the pleasure of seeing how the whole operation of the manufacture of one of these glow-lamps, such as we have above us now, is carried out. The carbons have already been formed, but the first process is that the cotton fibre is carefully tied and wrapped around pieces of carbon, as you see. It is then placed in a furnace and carbonised. After being thus prepared, a glass tube of special quality, selected for the purpose, is used to form the glass globe. Mr. Donaldson will take a piece of the glass tube before you, and will blow it into the shape similar to the lamp I hold, which is of the very familiar pear-like form. The carbon filament will then be fixed in the glass bulb, the latter will be exhausted and sealed, and the whole process be passed through before your eyes. I must first of all show you why it is necessary to take all this care. We have in front of the board one of these carbon filaments suspended, and we will now pass a current through it, and the carbon filament is raised to incandescence, it combines with the oxygen of the air, it is at once consumed, and, as you saw, we only had a light for a few seconds. Now, in order to make that light permanent, it is necessary to enclose the carbon filament in a glass globe, and to exhaust from that glass globe all the air, or as much of it as possible, and then, instead of having a life of a few seconds, the life of a lamp frequently continues for 4,000 hours or 5,000 hours. The first process, as I said, in making an incandescent lamp, after the carbon filament has been prepared, is that of blowing a glass bulb. The blow-pipe has now been put on, and the intense heat of the Bunsen burner raises the glass to incandescence, to a soft, plastic condition, so plastic that the manipulator can do with it just whatever he likes. Having got the glass to this particular shape, the filament will be placed inside it, first of all mounting the filament, which is an operation requiring a great deal of care and great skill in handling. It is an extremely pretty operation, and I beg to call your attention to it. The carbon is fixed inside a fine spiral of platinum, which is at the same time subjected to an intense current which decomposes the oil or the hydrocarbon in which it is placed, the carbon deposits on the carbon filament, and cements it to the platinum spiral. That is called mounting the filament. When that is done, the filament is fixed in the glass globe, and the platinum and glass are fused together. The brilliance of the platinum can be seen during this operation, and it is very pretty. I do not know how it would have been possible for us to have glow-lamps if it had not been for the fact that the co-efficients, or rates of expansion, of platinum and glass are practically exactly the same, and the result is that when the platinum and glass are combined together, as they are in a glow lamp, the two contract and expand at the same rate, and the result is there is no leakage; if there had been leakage through the glass it would have been quite impossible to have made a glow-lamp. The success of a glow-lamp depends upon the vacuum produced, and the next process is to cement the lamp so far to a vacuum tube connected to a mercurial air-pump. The one before you is Mr. Lane Fox's. It would have been also impossible to have produced these beautiful glow-lamps without the mercurial air-pump, so that the success of electric lighting and its perfection depend upon, first, the similarity

of expansion of glass and platinum, and secondly upon our power of producing a vacuum. As it takes ten minutes or a quarter of an hour to carry out the process of exhaustion, I will proceed with other portions of my subject, and presently, when the time is ready, Mr. Sillar will inform me, and we will light up the lamp that has been made before you this evening, and, I hope, with success. The operation we have just seen is one that has been just as interesting to me as it has been to you. There are very few who are permitted to see this operation. We once had it before in this hall when General Webber read a paper on glow-lamps, but with that exception I am not aware that the manufacture of glow-lamps has ever been shown in public before. It is most wonderful to watch the marvellous way in which glass can be twisted and turned to our ways and to our wants; and the skill with which the blower is able to manipulate glass in its plastic condition, and to shape it in any form he likes, is an operation which never ceases to excite one's wonderment. The form of lamp that is being made before us is of the ordinary size that we see used generally, but there are a great many different sizes of glow-lamps. For instance, here is a very small lamp; above me you will see, if I may call the small one a dwarf, there is a giant glow-lamp. It is a lamp invented by the Honourable Charles Parsons; it is made by the Sunbeam Lamp Company, of Gateshead, and is called the Sunbeam Lamp; it has the same proportion to an ordinary lamp that an ostrich egg has to a hen's egg, and the light from it is of equally large proportion, as you see now the current has been turned on to it. It gives a light of 400 candles, but it is rather too brilliant I see by your faces, and we will go back to our old friends of the ordinary size. There are also above us lamps of various sizes; there is a five-candle, ten-candle, sixteen-candle, twenty-candle, and a hundred-candle lamp. Here also are a fifty-candle Swan lamp, a sixteen-candle Swan, and an eight-candle Swan lamp. There are the ordinary sixteen-candle lamp; these are being burned from the Grosvenor Gallery. Here is a miner's lamp, which is supplied with a current by the Schanschieff battery, the same as I showed you at first; the peculiarity of this arrangement is that when the battery is turned upside down the light goes off, the zincs and carbons occupy one half of the cell, and the solution the other half, the zincs and carbons being at the bottom, and the battery is not excited unless contact is made with the carbons and zinc. Such a battery as this will maintain its lamp for 12 or 13 hours. There are several forms of the Schanschieff battery. Here is a portable form, and lamp connected with it by a flexible wire, which can be used when travelling; or in the night, when you want to know the time, you can have a lamp and battery like this by your bedside, and you can turn it upside down, and produce a light, see the hour, and turn the battery back.

These glow-lamps are used for different purposes and ways. They may be used with care, they may be used recklessly; their duration depends a good deal upon the care with which they are used. A practised eye, one who is accustomed to deal with electric lamps, can tell at a glance when the lamp is raised to a proper incandescence; but there is a point in all lamps that is a sign of danger, and indicates "breakers (or breakage) ahead." Whenever in an electric light installation a glow-lamp begins to show a blue effect, then breakers are ahead; the current must be reduced or other steps taken. I want to show you this blue effect, which is extremely pretty, and I want you to see the gradual stages through which a lamp passes, from long life to death, or rather to a very short and merry life. We can make the life of a lamp just exactly what we like; we can make a lamp last a minute, or we can make it last a hundred years, and the number of years of its duration is simply dependent upon the current employed. I have here a glow-lamp, and I pass a current through it. There is no blue effect at present; the current is increased and the carbon filament is raised to a high state of incandescence. In such a state it would not last for a long time, not more than ten minutes or a quarter of an hour; but it does not show the blue effect yet. On further increasing the current the blue effect appears, though I doubt whether it is visible to many of the audience; a little more current is put on, and the blue effect is very marked, the globe itself looks very brilliant, and, there, the current has been increased until the filament has parted.

It is always better, when making an observation or experiment to know what you are going to see, so that you can direct your attention to exactly what is being done or to what you want to know. If I put another lamp through the same experiment you will better able to understand this blue effect, and see just that point

where the lamp is about to give out. The current is now on, and is being gradually increased; the lamp is now intensely blue, and —there, it has gone in the same way exactly as the other one did. The way in which lamps burst is sometimes very beautiful; they disintegrate, they seem to volatilise, and the substance of the lamp is projected with great force against the side of the globe. On the table there are several beautiful specimens showing this effect.

The glow-lamp in process of manufacture before you is now being unsealed from the pump; it is now exhausted, and we will pass a current through it so as to raise it to incandescence. The current is now on, and you see the lamp burns with full brilliancy. The next experiment is rather a cruel one, because it is wilful destruction. I will not destroy the lamp that has just been made before us, for I will keep it as a memento of this evening. I want to show the safety of the electric lamp. Many people imagine that there is a great deal of danger about it. I will take a handkerchief, and in it place a lighted lamp, when, on the globe being broken the carbon filament instantly goes out, and there is no damage to the handkerchief, or the slightest appearance of scorching or heating upon it. On breaking that lamp you heard a report. That is due to the vacuum, which, on sudden rupture, the air rushes in to fill. These lamps will not only burn in air, but will actually burn in water. Here I have a lamp which on placing in a bowl of water continues alight in the water just as well as in the air. You can imagine what an immense boon that is to our divers and others who unfortunately have to work under water for our benefit.

I will not attempt to occupy your time in speaking of the beauties of this wonderful light, how it removes really poison from our air, how it is very good for sore eyes, because it burns with such steadiness that those who work under it really never find, in any shape or form, any inconvenience or discomfort to the eyes. It is extremely cleanly; it does not fill the air we breathe with noxious fumes. People are little aware of it, but it is a very simple calculation to show that thirty gas-burners produce a gallon of water in an hour, so that if you have thirty burners in a shop, for instance, alight for six hours, six gallons of water are produced, and the water can very often be seen running down the cold windows of shops. That water absorbs sulphur and sulphuric acid, and when deposited on books and decorations destroys them. If we could only get the electric light cheap, delivered at our doors, then everybody who has an idea of luxury and comfort would at once take it.

I want now to show you some of the dodges of the electric light. First I will show you that by the action of a cut-out an excess of current is prevented from injuring the lamps. A cut-out is inserted so as to protect a group of lamps here, and on a large current being sent you hear a crack, and the lamps have gone out; the safety fuse has perished in performing its duty. To prove this we will renew the cut-out, and on the proper current being turned on you see the lamps are sound. Here is an electric cigar lighter. I raise this up and the wire in front of it comes to a state of incandescence, and I have there, as you see, sufficient heat to light my cigarette. Some years ago, I had my daughter's doll's house, which was furnished by herself, fitted up with the electric light, and I thought that some of my younger hearers to-night, who were still in the doll age, would appreciate the way in which a doll's house can be lighted up by electricity. You now see the doll's house illuminated; it has a hall-door lamp which lights up on the opening of the door; the house has rooms furnished, occupied with handsome dolls, and fitted with every kind of contrivance; the doll who occupies the drawing room has the convenience of a portable lamp which she can move about wherever she likes, and each room and the kitchen has a particular form of lamp.

I have also here a model of that famous ship the *Captain*, which was wrecked off Cape Finisterre. The model has been fitted with electric light, and you now see the mast head-light, the red light for the port side, and the green light for the starboard side; there are high jinks going on in the saloon by the aid of the electric light; and there is also a search light which can be used for looking for the advance of the enemy. A beautiful phosphorescent effect is produced upon the water which is covered with blue cotton wool, in which a lamp is placed causing really a very pretty illustration of what the phosphorescence of the sea is like.

Here I have an apparatus for heating curling tongs by electricity; here is a flat iron treated in the same way, and here is a kettle in which the current is carried to boil water. I travel a good deal, and I alv carry in my travelling bag a battery like th ch is one of Pitkin's secondary batteries; it ght and ex-

tremely convenient; I can strap it on my shoulder like an opera glass. To this is attached a reading lamp which I fix in my waistcoat, and to the astonishment of my fellow travellers, when the shades of evening are beginning to set I take out the lamp and put it in operation so. My reading lamp is thus provided, and it is fixed in the most convenient position, for the light falls just where it is wanted, it does not offend the eye, and enables me to read the smallest print. I have always got with me my own light, perhaps much to the annoyance of my fellow passengers, and with the electric light machinery at my own house, I have little or no trouble in recharging the battery, or keeping it in order. The Pitkin battery is also applied to a miner's lamp. The effects of this wonderful power of electricity that we possess can be shown in many ways, and there are many other applications to lighting which I should have liked to mention, but I have much exceeded my allotted time, and must leave the rest of my subject until next Wednesday, when I will show you electricity in another form.

The process of making glow-lamps was shown by the Anglo-American Brush Electric Light Company. The London Electric Supply Corporation, Limited, showed an arc-lamp and a number of incandescent lamps in action, the current of some being supplied through a converter from the central station in Bond-street. Messrs. Johnson and Phillips exhibited a Brockie-Pell arc lamp. The Electrical Power Storage Company showed samples of their storage battery and plate. Various forms of lamps were shown by the Schanschieff Battery Company, lighted by means of their primary battery; and by Mr. James Pitkin, lighted by his secondary battery. Mr. G. Binswanger exhibited electric light fittings, and a kettle, flat-iron, and curling-tongs heated by electricity. The Incandescent Gas Light Company showed samples of the Welsbach light, and Mr. Sellon lent specimens of his incandescent gas light.

Obituary.

PROF. BONAMY PRICE, M.A.—Professor Price, Examiner in Political Economy for the Society of Arts since 1883, died on Sunday, 8th inst., aged 80. He was born in Guernsey, May 22, 1807, and was for a time a [illegible] of Dr. Arnold at Laleham. Dr. Arnold ha[illegible] high an opinion of Price's abilities that when [illegible] pointed Head Master of Rugby School, he kept the Mathematical Mastership open for some time in order that he might offer it to his former pupil as soon as he had taken his degree. To this mastership Price was appointed in February, 1830, having previously obtained a double first-class at Oxford in classics and mathematics in December, 1829. At the University he was associated with Cardinal Newman, and his brother, Francis Newman, in the famous Oxford movement, and in 1851 he wrote the article in the *Edinburgh Review* on the "Anglo-Catholic Theory," which was afterwards reprinted as a book. He was appointed Professor of Political Economy in the University of Oxford in February, 1868, and was the author of several works on the subject, to which he chiefly devoted his life. Prof. Price read a paper before the Society of Arts on "Buying and Selling; its nature and its tools," in May, 1881.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 18.—"Methods of Taking the Ballot." Three papers by JOHN LEIGHTON, JAMES WITHERS, and JOHN IMRAY. The ATTORNEY-GENERAL, M.P., will preside.

JANUARY 25.—"Theatres and Fireproof Construction." By WALTER EMDEN.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 17.—"Colonies of the Netherlands." By A. J. R. TRENDELL, C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 31.—"The Monumental Use of Bronze." By J. STARKIE GARDNER, F.G.S. E. J. POYNTER, R.A., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

JANUARY 27.—"The Public Health in India." By MR. JUSTICE CUNNINGHAM, of the High Court of Judicature, Calcutta. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE I.—JANUARY 30.—Yeast an organised cell.—Considered as a plant.—Why classed among plants.—How to be studied.—Phenomena connected with the growth of the cell.—Fermentation.—Kind of fermentation related to character and quality of yeast.—Conditions necessary to healthy growth.—Classification of the pure yeast cell among plants.—Its relation to the higher orders of plants.—Resemblances and differences.—How these are accounted for.—Its assimilating powers compared with those of the higher plants.—Yeast classed among the lower forms of vegetal life.—A fungus.—Its position among fungi.—A parasite or saphrophyte.—The characteristic features of its class.—Its relation to the other members of its class higher and lower in the scale.—Hyphal, sprouting and fission fungi.—Fungi capable of inciting fermentation and putrefaction.—Fungi capable of inciting alcoholic fermentation.—The yeast species defined.—Phylogeny.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R.A., on Thursday evenings, February 2nd, 9th, and 16th.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 16...Froebel Society (at the HOUSE OF THE SOCIETY OF ARTS), 7½ p.m. Annual Meeting.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. W. J. Steains, "Exploration of the Rio Doce, Brazil."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Announcement of Award of Medals and Scholarships. 2. Mr. J. M. Bryden, "Architectural Competitions and the Methods of their Decisions."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Dr. Fraser, "The Aborigines of Australia: their Ethnic Position and Relation."

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The Ancient Eastern Empire."

TUESDAY, JAN. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. A. J. R. Trendell, "The Colonies of the Netherlands."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. J. Romanes, "Before and After Darwin." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion on paper by the late Mr. Hamilton Goodall on "The Use and Testing of Open-hearth Steel for Boiler-making." 2. Sir Bradford Leslie, "The Erection of the 'Jubilee' Bridge over the River Hooghly, on the line of the East Indian Railway."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Benjamin Jones, "Progress, Organisation, and Aims of Working Class Co-operators."

Pathological, 53, Berners-street, Oxford-street, W. 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Oldfield Thomas, "A collection of Mammals obtained by Dr. Emin Pasha in Central Africa, and presented by him to the Natural-History Museum. 2. Mr. Arthur G. Butler, "The Lepidoptera received from Dr. Emin Pasha. 3. Mr. Edgar A. Smith, "The Shells of the Albert Nyanza, Central Africa, obtained by Dr. Emin Pasha." 4. Mr. A. G. Butler, "Descriptions of some new Lepidoptera from Kilima-njaro."

WEDNESDAY, JAN. 18...SOCIETY OF ARTS, John-street, Adelphi, W C., 8 p.m. Messrs. John Leighton, James Withers, and John Imray, "Methods of Taking the Ballot."

Meteorological, 25, Great George-street, S.W., 7 p.m. Mr. G. M. Whipple, "The Non-Instrumental Meteorology of England, Wales, and Ireland, 1878-1885." 8 p.m. Annual General Meeting. Address by President (Mr. W. Ellis).

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Mr. H. T. Munday, "Steel Sleepers."

THURSDAY, JAN. 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Spencer Moore, "Influence of Light on Protoplasmic Movement." (Part II.) 2. Dr. R. W. Schufeldt, "Studies of the Machrochires." (Humming bird and allies.) 3. Mr. W. H. Beely, "New British Plants."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. T. E. Thorpe and W. T. Smith, "Morindon." 2. Messrs. T. E. Thorpe and F. J. Hambly, "Manganese Trioxide." 3. Prof. Lunge, "Contribution to the Theory of the Vitriol Chamber Process." 4. Mr. Lewis T. Wright, "Studies in Coal Distillation."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. A. Barrett, "The Material of Music." (Lecture VI.)

Society for the Encouragement of Fine Arts, 8 p.m. Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Herkomer "The Walker School."

Historical, 11, Chandos-street, W., 8½ p.m. Mr. F. Solly Flood, "The Dispatches of Prince Henry of Monmouth during the War in Wales, 1402-1405, and the Treaty of Surrender of the Welsh Chieftains."

FRIDAY, JAN. 20...United Service Inst., Whitehall-yard, 3 p.m. Captain R. F. Johnson, "The Principles that govern the handling of the Artillery of an Army Corps."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Rayleigh, "Diffraction of Sound."

Philological, University College, W.C., 8 p.m. A Dictionary Evening by Dr. A. H. Murray.

SATURDAY, JAN. 21...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture I.)

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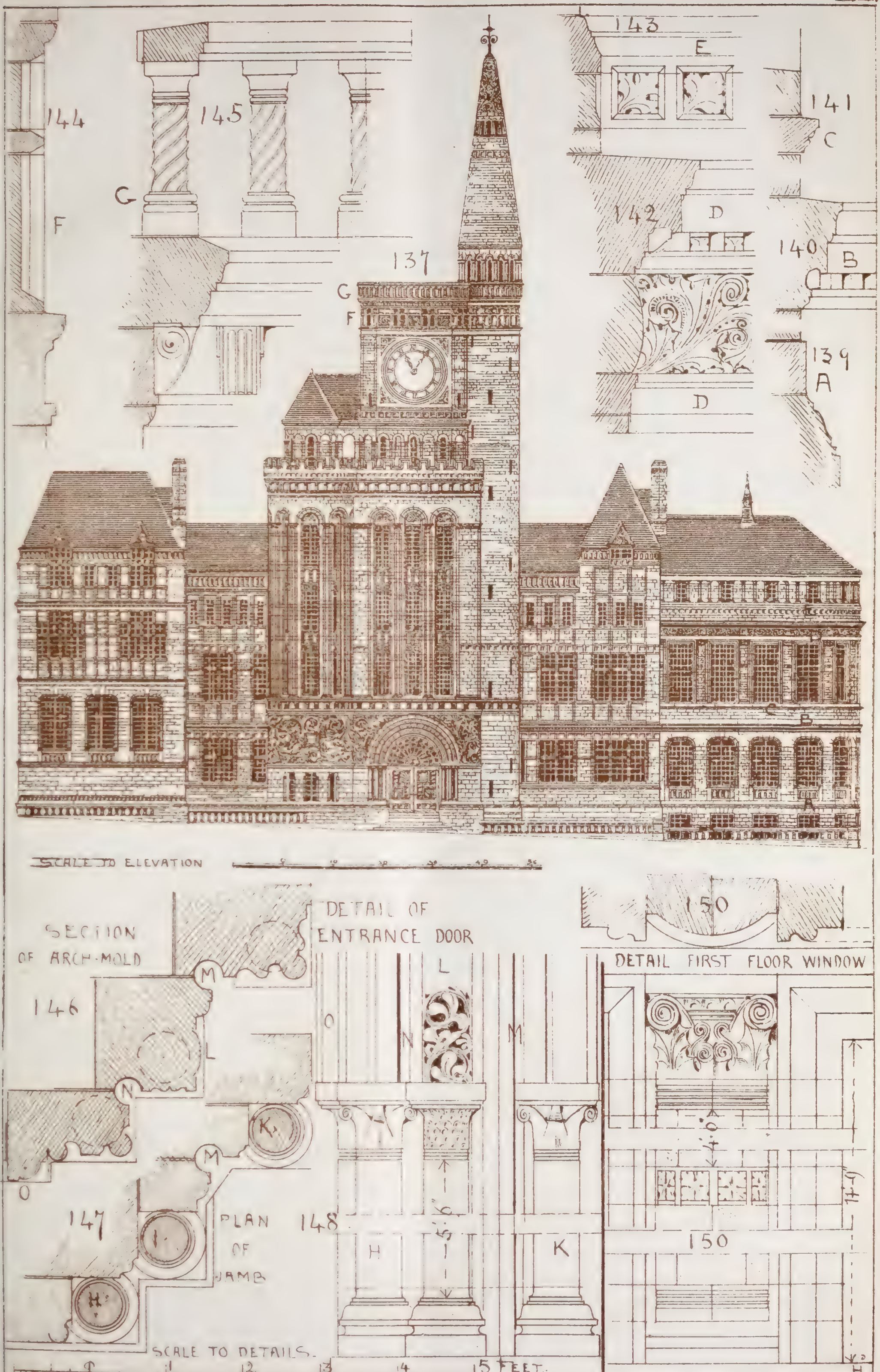
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FRIDAY, JANUARY 20, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MOTORS FOR ELECTRIC LIGHTING.

The Council desire to give notice that the tests for prime movers suitable for electric light installation will be carried out at a date to be fixed hereafter, during the spring of the year. As soon as the necessary arrangements have been completed, due notice will be sent to the competitors.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.

By W. H. Preece, F.R.S.

Lecture II.—Delivered 11th January, 1888.

Last Wednesday I had the pleasure of showing you how electricity was employed to produce heat, and how, by means of the heat resulting from the passage of electric currents, we obtained light. To-night I intend taking you in a different direction altogether. I want to disabuse your minds of the idea that electricity is a prime mover in the sense we generally consider prime movers to be. It is nothing of the sort; it is simply an agent or a medium by which energy, such as I showed and described to you last Wednesday, can be passed through one of its stages. The first form of energy that I am going to call your attention to to-night is of the character generally called work. It means something done; objects moved, resistance overcome.

In all these actions of electricity that I am going to show you—if an electric current, for instance, moves a magnet, a magnet moved will produce electricity; if an electric current, as I showed you last Wednesday, produces heat, heat in its turn will produce electricity, and so we have throughout the whole range of mechanics and of science this principle of reversibility introduced. For another instance, suppose we compress air or gas, the gas always reverses the action, and exercises a reaction precisely equal in amount to the action that caused the compression. Take a letter-weight. If you want to weigh a letter you do so simply by compressing a spring, and the weight of the letter is measured by the reverse action of the spring in pressing the letter upwards. If you take a weight and lift it, wherever it may be, that weight is in a position to produce the reverse action. If we take two magnets or two currents of electricity and forcibly separate them, there is also always this reaction between them.

I will first of all once more refer you to the hand-dynamo, which will work and produce currents of electricity that will enable me to produce on the table before you some effects. Last week I showed you how we could obtain heat. To-night, as some of the effects I want to show you are rather minute, my friend, Mr. Lant Carpenter, has undertaken to assist me by throwing upon the screen behind me certain pictures conveying more vivid ideas of what I want to express than if I were to attempt to do so with the small apparatus that I have on the table.

I want, in the first place, to show you what is meant by a magnetic field. We have now on the screen the projection of a steel magnet, it has been charged with magnetism, and as Mr. Carpenter now scatters over a glass placed above that magnet some very fine iron filings, you see that they arrange themselves in straight

lines and curves, and when the glass is gently tapped, those lines all arrange themselves in a radial fashion, with beautiful symmetry, in the most wonderful way, every particle being directed by attraction towards the pole: one pole of the magnet only can now be seen, though, of course, every magnet has two poles. From that I want you to see how those lines picture to us the conditions of the space that surrounds every magnet, and in every single experiment that I am going to show you to-night the currents that we obtain are currents due to the fact that we can force copper conductors to pass through what is called a magnetic field; the neighbourhood of a magnet, such as you saw just now on the screen, is called a magnetic field. Whenever a copper conductor, such as the wire I now have in my hand, or a wire arranged in other forms, is caused to pass through a magnetic field, it becomes electrified, it acquires that condition which enables us to obtain currents, and to use those currents.

I will now show you that we can utilise currents produced by this hand-dynamo to attract and repel particles of iron. You now see on the screen two poles of an electro-magnet; the difference between a permanent magnet and an electro-magnet is that the one is made of steel and the other of soft iron. The permanent steel magnet acquires and retains its magnetism for a long time, whereas in an electro-magnet the magnetism only exists during the time that a current is passing round the soft iron core. The picture shows the two coils of copper wire which, with their cores, form the electro-magnet. Mr. Carpenter places some iron filings on that magnet, and on raising it they simply fall off, because there is no power present to attract them; I now cause a current to pass, and the iron filings being presented they are attracted, and continue so as long as the current is passing. The moment the current ceases the filings fall. That experiment failed at first, because a loose connection of one of the wires had been made, and no current passed. Faraday once made a remark that an experiment never failed. He said, "An experiment never fails; something happens that requires further investigation!" In that experiment we have seen one of the simplest and most interesting elementary experiments in electricity. You have now seen that in a magnetic field we have the production of certain lines of magnetic force, and that currents of electricity produce magnetic fields. I want now to show you that whenever a conductor is passed through a magnetic field, work is done upon that conductor, it receives a kind of reaction, currents of electricity are produced. Similarly, if the conductor be placed in the magnetic field and a current from another source be passed through it, it is urged to move in a certain direction. I am going to show you the instrument itself if I can, but Mr. Carpenter has a similar instrument in the lantern, and the experiment will be repeated before you in another and different form on the screen.

The fact that I want you to understand is, that whenever we pass a current of electricity through a conductor in the neighbourhood of a magnet, or in a magnetic field, it has a tendency to be moved or to rotate around that field in a definite direction. Here I have a horseshoe magnet; it is surrounded by a cage of copper wire, and through that cage I will cause a current of electricity to flow, and if my current is all right (we cannot always ensure that currents will go right—there are a good many wires about this table) the experiment will succeed. If the currents do not go, we will find out why they do not go; if they go right, you will see these coils move. You now see that the coils are rattling round at a rapid rate. I take the current off, and they stop; I put the current on again, and away they go. There you have an illustration of the fact that whenever you have a conductor in a magnetic field, and the conductor is traversed by a current of electricity, it is always urged to move.

I ought to point out to you that here we have the basis of every single experiment I am going to show you to-night. A current of electricity produced rotation, as you saw, in that cage, and in this particular form that I want to show you on the screen you will see that rotation is produced in another way. You now see the apparatus on the screen. On the left and right hand side there are two upright columns, the poles of the magnet, exactly similar to the one I showed you on the table. Between those two poles there is an iron armature rotating on a centre point, and that armature is enveloped at each end by a small coil of copper wire. When a current of electricity passes through that copper wire it magnetises the iron bar, and the iron bar gets attracted and repelled by the two poles of the magnet, so that on my now putting the current on, you see, away it goes. The application of that principle has been carried out in the little

apparatus I have here, called Froment's motor. This particular Froment's motor is used to wind a clock; in fact, it has only just been taken from a clock which, at twenty minutes past every hour, was wound up by a current of electricity actuating this motor. By its means the hand winding of clocks is dispensed with, and, supposing a battery will last for years, so the clock will keep time for years without one being troubled by the necessity of going round the house and winding up the clocks. In order to show you, in a pretty way, one effect of this rotation, I have, through the kindness of Mr. Apps, brought here a motor which works a disc on the front of which some vacuum tubes have been fixed. Here is an induction coil which will produce currents of electricity that pass through these vacuum tubes and illuminate them, and when, by means of the motor, I cause the disc to rotate, you see what beautiful optical effects the persistence of vision produces when you look at electric sparks passing through vacuum tubes filled with a very slight proportion of different gases.

In this room there is always a very pleasant reminiscence, and a grateful recollection, of one of our most distinguished chairmen, Sir William Siemens. There is no man who has done more for the practical application of electricity in this country; he brought this very subject before us on various occasions, and I thought I could not do better than throw upon the screen that speaking portrait of our much-missed friend.

I will now show you how electric currents can be used to produce rotation or to produce motion. The history of motors is extremely interesting; it commences in the year 1823, when Mr. Barlow, the father of the present well-known engineer, the engineer of the Tay Bridge, and past President of the Institution of Civil Engineers, showed how it was possible to produce rotation by means of currents of electricity. The great apostle of electricity, Faraday, in 1831, did the same thing; and in 1833, Ritchie produced that very instrument that I showed you; but as far back as 1839, there was a Scotch gentleman, of the name of Davidson, who thought that this principle was applicable to the drawing of trains on railways, and I have a slide, which Mr. Carpenter will now throw upon the screen, showing his locomotive.

You now see a picture of that machine, as used on the Edinburgh and Glasgow Railway, or rather, I will not say it was used, because I do not think it could have been used, but it was tried on that railway as far back as 1842. You see there were eight electro-magnets, through which currents were passed, and there rotated the wheels. The machine worked at the rate of nine miles an hour. Other distinguished scientists have worked in this direction. Jacobi, of St. Petersburg, about the same time, drove a boat on the river Neva by means of an apparatus very similar to Davidson's. Froment, whose apparatus I showed you, applied this principle to his workshops in Paris; the tools in his shop were worked by an exactly similar motor to that which I showed you just now. Motors are innumerable; I have on the table here models of all the various patterns. Here is a very well-known motor, the invention of an American named Griscom; here is a motor, and I have no doubt if I pass a current of electricity through the electro-magnet of which it is formed, you will see that it rotates rapidly, and works a fan. I will not dwell much on the various kinds of motors that are used. Mr. Immisch has distinguished himself very much in this direction, and I shall show you several of his motors at work. Mr. Parker, of Wolverhampton, has made one of the prettiest motors, and I shall show you it also at work. There is nobody who has done more for the practical application of this principle than Mr. Reckenzaun, and I shall show you his motor; and again, Dr. Hopkinson, as well as the house of Messrs. Siemens, have done an immensity to assist this application of electricity.

But I want to illustrate to you the property that the electric current has of transferring power from one place to another. We can produce power in this room, and we could, without difficulty, transfer the power produced here to Liverpool, to Edinburgh, or even to New York; there is absolutely no difficulty whatever in transferring from this very room energy produced by means of the dynamo machine, and sending it, if you like, to Kamtchatka. Of course, the amount of energy you are able to transmit is quite another question; the amount varies very much with distance. Telegraphy is entirely dependent on the power which electricity gives us to reproduce mechanical effects at a distance. It would have taken a good deal too much time to have brought before you to-night the various systems of telegraphy; I will show you one, and that one of the earliest and

simplest, the old A B C telegraph of Wheatstone. Here is one: it contains a little dynamo machine; when I turn the handle round I am converting the energy of my body into currents of electricity. Currents of electricity are produced by turning the handle, and I am able, by means of little finger keys (similar to the keys of an accordian) placed around the machine, to adjust or arrange the number of currents of electricity that go to the end of the table where the receiving instrument is fixed. As far as the apparatus is concerned, it does not matter whether the motor and receiver are separated by eight or ten feet, or by eight or ten miles. You see by this power we are able, in telegraphy, to transmit signals to any distance we like, and at any speed we like. I have mentioned that this power is used for winding clocks, and I will not refer to that again; but this power of transmitting energy to distances is used for a great many practical purposes. For instance, all of you who travel by railway, and I doubt whether anybody here does not travel by railway, are dependent upon this power of electricity to secure safety, and to give knowledge of the approach and departure of trains. Sounds can be produced by striking blows, blows being the expenditure of energy, and here I have a bell which is struck by its hammer whenever I send an electric current through its magnet, and so I reproduce by the current an action similar to that of the elbow. But this same power that electricity gives us to reproduce energy at a distance, can be used for purposes which some would be inclined to say are more useful than telegraphy. There may be some people who still look upon a telegram with an amount of horror, and when an envelope containing a message is handed to them immediately turn pale and feel themselves rather affected; but, while many do not care about telegrams, everybody likes water. It does not matter to what class a person belongs he indulges some time or other in water, and any apparatus that will facilitate the production of water will attract our attention. I have here the little Parker motor I mentioned, and a pump. When I send a current of electricity the motor works, and in its turn, by a pulley, works the pump. Mark you, the pump and motor are only a few feet from me, but it would be just the same if they were ten miles away. This simple system of pumping water by electricity is used to a very large extent. There are a great many people who employ electricity now, as I told you at our last lecture, to light their houses, and those who employ electricity to light their houses can employ the same currents and the same power exactly to raise water.

There is a friend of mine near East Grinstead, Sir Francis Truscott, who has his house fitted with electricity. He used to employ two men every day in raising water from a depth of 150 feet to fill his tanks, but when he had secured the use of electricity for lighting his house, I suggested to him that he might just as well use it for raising his water. It was no sooner suggested than acted upon. A little motor, not much larger than that you just saw, works for two hours a day, and supplies a full quantity of water for the house, and the services of the two men were dispensed with in that respect. There is no reason on earth why those people in the country who depend upon manual labour for the raising of water cannot raise their water with greater speed and more efficiency by means of an electro-motor; in fact, this is carried out to a very large extent in South Wales by Mr. Brain. In the collieries in the Forest of Dean electro-motors are used to a very large extent to raise water from depths of hundreds of yards, and through distances that approach from a mile to two miles. Well, the same power exactly that can be used to raise water can be used for many other purposes.

The present Prime Minister of England is a very advanced electrician. There is no man in England who has applied electricity so much for domestic and useful purposes as Lord Salisbury has at Hatfield. He was one of the earliest in the field; he has at Hatfield currents of electricity which are not only used for pumping but also for chaff cutting, turnip cutting, for sawing timber, and for many other farming and domestic purposes.

To-night I am also able to show you this operation of sawing by electricity. The same motion that you saw in raising water we will apply here. Through the kindness of our chairman, Mr. Anderson, we are able to show the arrangement we have here. At one end of the table we have an Immisch motor; it is so small that you can scarcely see it at a distance, it would go in a moderately sized hat, but it will, on a current of electricity going through it, develop three-horse power. It will set a pulley in rotation, that pulley has a strap on it which works the counter-shafting behind me, and from this counter-shafting there are bands that work two or three machines that I shall refer to directly. I now want to call your

attention to the circular saw which has been lent us by Messrs. Churchill. Sawing in country houses like Lord Salisbury's is required for cutting up the timber required for fires and for many other purposes, and here we have, by means of this motor, the countershaft and the circular saw at work. Here also is a Singer sewing machine driven in the same way.

The next purpose that electricity is used for, to which I want to draw your attention, is that of the transmission or propulsion of coaches on railways. I have taken the trouble to find out the various railways and tramways in America, in Great Britain, and on the Continent, that are now worked by means of electric currents. Here is a list of them :—

Electric Tramways in America.

The *Electrician and Electrical Engineer* gives the following list of electrically-worked tram lines now in actual operation in the United States :—

Town.	Line.	Conductors.	Length of line.	System.
Appleton, Wis.	Appleton Electric Street Railway	Overhead	4½ miles	Van Depoele, 5 motor cars.
Asbury Park, N.J...	Lea Shore Electric Railway	,,	4 ,,	Daft.
Baltimore, M.D. ...	Union Passenger Railway Company	,,	...	Daft.
Bellevue, Pa.	... ...	...	½ ,,	——
Binghampton, N.Y.	Washington Street and State Asylum Electric Railroad	Overhead	5½ ,,	Van Depoele.
Denver, Col.	Denver Tramway Company	Conduit	4 ,,	Short-Nesmith, series.
Detroit, Mich.	Detroit Electric Railway Company	Overhead	2 ,,	Van Depoele, 4 motor cars.
,, ,,	Highland Park Railway Company	,,	3 ,,	,, ,, 2 ,, ,,
Gratiot, Mich.	Gratiot Electric Railway Company	,,	...	,, ,, 1 motor car.
Ithaca, N.Y.	Ithaca Street Railway Company	,,	...	Daft.
Kansas City, Mo....	Kansas City Electric Railway Company	...	...	Henry.
Lima, O.	Lima Street Railway Motor and Power Company	Overhead	6½ ,,	Van Depoele, 7 motor cars.
Los Angeles, Cal....	Los Angeles Electric Railway Company	,,	5 ,,	Daft, 4 motor cars.
Mansfield, O.	... ...	,,	...	Daft.
Montgomery, Ala...	Capital City Electric Street Railway Company...	,,	11 ,,	Van Depoele, 20 motor cars.
Port Huron, Mich...	Port Huron Electric Railway Company	,,	2¾ ,,	,, ,, 3 ,, ,,
Richmond, Va.	Richmond Union Passenger Railway	,,	...	Sprague motors.
St. Catherine's, Ont.	... ...	,,	6 ,,	Van Depoele.
Scranton, Pa.	Scranton Suburban Railway Company	,,	2¼ ,,	Van Depoele, 3 motor cars.
Wichita, Kan.	Wichita Riverside and Suburban Railway Co.	,,	4 ,,	,, ,, 6 ,, ,,
Windsor, Can.	Windsor and Walkerville Electric Railway Co....	,,	1½ ,,	,, ,, 1 motor car.
Woonsocket, R. I...	Woonsocket Street Railway Company	,,	...	——

Electric Tramways on the Continent.

Town.	Line.	Conductor.	Length.	System.	Power.
Amsterdam	Cortverloren Park	Overhead.	½ mile.	Siemens.	Steam.
Berlin	Lichterfelde (Berlin-Anhalt Railway)	Rails.	1·6 ,,	,,	,,
Brussels	Tramways	Nil.	...	Accumulators (Julian).	,,
Charlottenburg	Spandauer Rock	Overhead.	...	Siemens.	,,
Cologne	Tramways	Nil.	...	E.P.S. Accumulators (Hüber).	...
Frankfort-on-Maine	Frankfort to Offenbach Railway	Overhead.	4·1 miles	Siemens.	Steam.
Hamburg	Tramways	Nil.	...	E.P.S. Accumulators (Hüber).	...
Hohenzollern	Hohenzollern Colliery (Upper Silesia)	Overhead.	½ mile.	Siemens.	Steam.
Vienna	Moedling-Hinterbruel (Austrian Southern Ry.)	,,	2·8 ,,	,,	,,
Zankerode	Zankerode Mines, Saxony	,,	½ ,,	,,	,,

ELECTRIC TRAMWAYS IN GREAT BRITAIN.

Town.	Line.	Conductor.	Length.	System.	Power.
Blackpool...	Blackpool Tramway	Buried central rail.	2 miles.	Holroyd Smith.	Steam.
Brighton ...	Brighton Beach	Rails.	1 ,,	Volk.	Gas.
,,	Brighton and Shoreham Tramway	Nil.	4 ,,	Electric Traction Syndicate (Accumulators).	Steam.
Glynde	Glynde Clay Pits	Open.	1 ,,	Telpherage.	,,
London	North Metropolitan Tramways (Stratford & Manor-park)	Nil.	4 ,,	Elieson (Accumulators).	,,
Newry	Bessbrook and Newry	Raised central rail.	$3\frac{1}{4}$,,	Hopkinson.	Water.
Portrush ...	Portrush and Bushmills	Raised side rail.	6 ,,	Siemens.	,,
Ryde, I.W.	Ryde Pier	Rails.	$\frac{3}{4}$,,	Siemens.	Gas.

You will see how greatly and how rapidly this great power that electricity gives us is being utilised for useful purposes. One of the earliest lines upon which the power was used was the Portrush and Bushmills Railway, in Ireland. Near Portrush there is that wonderful formation of rocks known as the Giant's Causeway, and in order to see this remarkable geological structure, people travel a distance of some six miles. Not far from the line of route between Portrush and the Giant's Causeway is a place called Bushmills, through which a river runs, and this river has a very pretty, and at the same time useful fall of water, which is utilised to work dynamos, which transmit currents of electricity through an insulated rail alongside the track of the railway, to supply motive power to the cars. You now see a picture of the tramcar used; that is a plan of it; the other is a perspective view; the motor itself is shown in plan. You see the two electro-magnets, and the armature, or coil of wire, that rotates is in the centre. The rotation of that armature is transmitted to the wheels by means of the chain-gearing that is shown. This railway at Portrush has been the forerunner of a great many railways in different parts of the world, but the most complete and the most perfect railway of its kind has lately been carried out by Dr. Edward Hopkinson, Sir William Siemens's assistant in carrying out the Portrush Railway. I refer to the Bessbrook and Newry Electric Railway. Instead of showing you a drawing of this railway, Dr. Hopkinson has made and sent us a model; that model is fixed to the wall of this room by five brackets, on which the rails have been placed, and a coach. A small motor is attached to the coach. When I turn on the switch, you see, away goes the car along the railway, and on getting half-way it passes a brass pillar, catches a switch, which reverses the current, causing the car to return.

I read once a rather curious paragraph in a Belfast paper about the Portrush Railway. It was supposed that persons got shocks by stepping on one rail and touching the other. The paragraph ran as follows:—"A rather mysterious affair has happened in connection with the insulated electric rail on the Giant's Causeway and Portrush Tramway. It appears that country people are in the habit of touching the rail and receiving harmless shocks, but on Thursday evening a ploughman, returning with his horses, stood on the rail to mount. [Well, he could not; there was no rail to enable him to mount; the rail is on the wrong side.] Immediately on applying his hands to the horse's back, the brute fell dead against the rail. The strange part of the affair is, that the man was uninjured, although the current passed through his body to the horse." That is a sample of reliable history!

Now we will throw upon the screen a picture of an electric railway that was used at the Paris Electrical Exhibition in 1881. Exhibitions have been very celebrated for electric railways; there was one at Paris, another at Munich, at Vienna, Antwerp, Philadelphia, the Inventions Exhibition at South Kensington, and at Edinburgh, but the picture you now see is of that at Paris, which carried a great many passengers for a distance of about a third of a mile to the Electrical Exhibition there: the peculiarity of it was that the conducting wires were overhead, and the rails were not made use of as at Newry and Bessbrook.

Another application of electrical power tried at the Paris Electrical Exhibition was carried out by M. Tissandier, who attempted to navigate a balloon by its means. The balloon

worked satisfactorily inside the Exhibition building, but failed when tried in the open air, being simply carried away by the air currents, having nothing for the fans to work against. A good deal more is wanted to be known before we can possibly solve the difficulty of navigating balloons, and at present we are simply dependent upon currents of air to carry us from one place to another.

A very curious departure from the ordinary practice of conveying materials was started by Professor Fleeming Jenkin, who is, unfortunately, now no more, and he, in conjunction with Professors Ayrton and Perry, started a system called telpherage. There we have a picture of the telpherage system, introduced near Glynde, a station on the Brighton Railway. Not far from Lewes, a mile or mile and a quarter from the Glynde Railway Station, in the Downs there are certain clays which are valuable, and from the clay-pits the clay is sent down to Newhaven for shipment abroad. This system of telpherage carries the clay from the pits to the station by means of electricity. Two heavy wires are fixed on cross-beams, or posts, which pass over the meadows, they do not interfere with the roads, or the grazing of cattle, they pass through bogs, marshes, rivers, and anywhere you like, and on these wires skeps—a kind of bucket—are carried on rollers, by which they pass along. Each skep carries about half-a-hundredweight of stuff. In the centre of the picture you will see the motor, or locomotive, which is worked by electric currents generated at Glynde and transmitted through the wires. The arrangement is extremely ingenious, and daily and hourly trains pass by this means over the Downs to Glynde Railway Station carrying the clay. Such is the telpherage system.

But there is one system of carriage where electricity is destined to become more useful and more valuable than any other that I have brought before you, and that is in the working of a system of tramways in towns. There are few people who know that the number of horses required to work a tramway is 12 per car. My figures are taken from Manchester, where there is one of the best worked systems of tramways that we have in this country. There every car requires 12 horses to work it; the life of a car horse on those tramways is only four years. Working tramways in the north, wherever there are heavy gradients, is really cruelty to animals. We know that a horse can only do a horse's work; there are some men who can do a good deal more than an ordinary man's work, but we rarely should expect any man to do more than five or six men's work. But these tramway horses are absolutely frequently called upon to do eight or ten times more than nature has constructed them to do, and it is no wonder that their life is so very short. This remarkable fact comes out in dealing with horses from a pure matter-of-fact point of view. If we work a tram-car by electricity by means of batteries placed in the car, taking the price of horseflesh and the price of batteries per ton, the cost is exactly the same—it requires a ton-and-a-half of horseflesh, it requires a ton-and-a-half of batteries, to work a car. The life, as I stated, of a car horse is four years, the life of a battery is four years. A horse will hardly do more than thirty miles a day; a battery will carry a car for sixty miles a day, and, in fact, when we remember that for the price of two horses, for the life of two horses, we can work tramcars by means of electricity, then when you think that it takes twelve horses, the mere question of £ s. d. will carry the day. There is not the slightest doubt that, when the matter is properly and thoroughly worked out in a practical manner, batteries can and will work tramways, and the day is not far distant when all our tramways in and about London will be worked by means of batteries, and the poor horses relegated to duties for which they are better fitted.

We will now go back to some of the other purposes, and the one purpose that I wish to refer to is the power that electricity gives us to utilise the waste powers of Nature. Wind, tides, and falling water are to be found everywhere, and if they can be utilised economically will certainly be so used. I have shown you, in the case of the Portrush Railway, how water power is utilised in this way. In the Bessbrook and Newry Railway water power is utilised in precisely the same way. At Craigside, near Newcastle-on-Tyne, Lord Armstrong is able, by means of the energy of a waterfall in his grounds, to light up his house and to do various other things. In France M. Felix has used this same property for ploughing. You will see on the screen a picture of the way in which the power of electricity is so used.

Again, at the Paris Electrical Exhibition, there was a Siemens lift worked by electricity, by which people were raised from the floor to the gallery. Dr. John Hopkinson has also worked in this direction, and a drawing of his plans now appears on the screen. This

system of lifts worked by electricity is utilised at the present moment in London at at least two banks, the River Plate Bank, and the Bank of Rio Janiero, for carrying books and bags between the various floors of the premises. This power of electricity is more easily applicable for lift purposes than almost any other.

There is an experiment which I wanted to show you earlier, and as it is rather a pretty one I will show it you now; it is the power that electricity has to draw or raise a weight. This was used by Marcel Desprez, in Paris, for an electric hammer. I have here a weight that will pass up through a coil of copper wire. When a current of electricity is sent through the coil the weight is sucked up, and there you see, by means of electricity, I am able to produce blows, and it only requires more electricity and a heavier weight to produce the effects of a hammer.

There is another application of electricity that has been attracting a good deal of attention at Brighton. Mr. Volk, who has done a great deal towards the application of electricity down there (he has laid an electric railway along the beach), has started an electric dog-cart. He has fitted a dog-cart with batteries, and it goes bowling about Brighton without a horse. He, his wife, and daughter, are to be seen taking their airing along the Parade in a vehicle that looks like a dog-cart, but there is no horse in it.

I now show you a picture of an electrical tricycle, brought out by Professor Ayrton, which was at the Vienna Electrical Exhibition.

When I was last in America, Mr. Edison, who is one of the most ingenious men alive, gave me what he calls his electric pen. It is in the form of a pencil, but instead of lead, the core of the pencil consists of a very fine needle, which has an up and down play of about 1-16th of an inch, and by its movement backwards and forwards, caused by a little electro-motor, the point makes small holes in the paper. I write "W. H. P." To take copies of what is written, I should simply rub an ink-pad over the little holes, when I should have "W. H. P." printed on the paper, and could strike off as many copies as I liked.

The motor that Mr. Volk uses for his dog-cart in Brighton is also used for ventilating. I have here a fan which is moved by an Immisch motor which rotates at the rate of 500 or 600 revolutions per minute. As I showed you before, this same power of electricity can be used for working sewing machines. This sewing machine is worked by an electro-motor, and it must be a comfort to those who constantly use such machines for domestic purposes, as by the use of electricity much fatigue is prevented.

Electricity has been applied to boot cleaning, to knife cleaning, and there is no reason why it should not be used for churning. It can be used, as you have seen, for ventilating, It can be used for sweeping. The same power can be used for mowing machines, and many other purposes. Sir David Salomons has devoted his whole life to scientific pursuits, and his house is fitted up with electricity. He has a workshop fitted with all the latest and most perfect tools, all of which are worked by electricity. We are going at such a pace in the diminution of labour, that one of these days I should not be at all surprised to see that electricity will work the dirty iron ore from the mines of Bilbao into a magnificent 10-inch gun, better than anything that the establishment at Woolwich has produced. For toy purposes we have lots of things on the table, ships, electro-motive engines, zoetropes, and all sorts of things worked by electricity, but they are for your merriment after the lecture, rather than for your instruction during the lecture.

A distinguished electrician has dispensed with waiters at the dinner table by the use of electricity. He has fitted a small electric railway on the dining table, along which the courses are carried and removed as required, and you now see a picture of the arrangement on the screen.

The clipping of horses can be done by this electric power better than by the hand process, with less injury to the animal, and far better than the old singeing process.

Electricity is also used for propelling boats, and you see a picture of the *Cygnus*, a boat used at the Paris Electrical Exhibition of 1881; a little Trouvé motor works the screw. Now you see a picture of the boat *Electricity*, and the rate at which these boats are propelled is pretty considerable. There is a diagram on the table of the electric launch recently tried at Havre by the French navy; it is not a very elegant looking boat, but I believe it goes with great velocity, and gives satisfaction. I have had the pleasure of going up the Thames in an electric boat made for the Duke of Bedford, and I have been up the Danube in another electric boat. I am looking forward to the

time when we may have electric boats on the Thames. It only wants some enterprising firm to establish machinery at charging depots at Teddington, Reading, and other places, to enable boats to be propelled by electricity.

All the applications of electricity that I have shown you have been by way of peaceful purposes, but the same power can also be used for the destruction of our enemies. I have here a miniature ship in a bath containing water. It represents a pirate vessel with its black flag and skull-and-crossbone ensign flying, sailing along seeking its prey. On the pan containing the water there are two marks, and when the boat gets between them I know it is in the vicinity of a submerged torpedo, and on sending an electric current the torpedo explodes, and blows up the ship and all its crew to destruction. That concludes the experiments that I intend to show you.

I have shown you various ways in which it is possible, by the proper utilisation of electricity, to economise labour; but there is always this fear, that if too many means of economising labour are introduced it may lead to idleness and evil. Still, when labour is saved in one direction it is given in another direction, and the result must evidently be beneficial in the long run.

I have brought before you some effects of one of the great powers of Nature, and I have shown you in these two lectures, in a very rough and hasty manner, how it is applied to useful purposes. Every single purpose which I have shown you was in itself deserving of a lecture occupying a whole evening; but, however, to the best of my ability I have endeavoured to bring these matters before you, and I have been assisted in them by the very generous way in which others have come to my help. My friend Mr. Lant Carpenter has helped me considerably; Mr. Probert, Mr. Heather, Mr. Davenport, and others have all assisted. Mr. Immisch and Mr. Binswanger have been kind in their loan of motors, and our Chairman this evening has been the means of my carrying out several of the experiments, and others have come forward with a liberality that is really overpowering. I am only too glad to think that I have succeeded in keeping your attention together for these two nights, and, I hope, shown you something that you have never seen before, and which, I trust, may lead you to see a good deal more of in the future.

The CHAIRMAN proposed a very hearty vote of thanks to Mr. Preece for the lectures he had delivered. He said that those who hear lectures had very little idea of the enormous amount of labour and forethought, as well as devotion of time and energy, necessary to get together everything that is necessary for the lectures to work smoothly. The Chairman added that they must not forget, as Mr. Preece had reminded them, to thank Mr. Lant Carpenter and others for the voluntary services they have rendered in order to make these lectures the success which they most assuredly had been.

Mr. PREECE acknowledged the vote of thanks, and the meeting then adjourned.

Messrs. Churchill and Co. lent a saw bench, and Messrs. Singer a sewing machine. These machines were driven off a counter shaft lent by Mr. W. Anderson, the shafting being driven by an Immisch motor belonging to the Society. Messrs. Immisch showed a small motor driving a Crossley ventilating fan. The Electric Apparatus Company exhibited models of various dynamos and motors, and also an electric horse-clipper. Messrs. Binswanger showed a sewing machine with motor attached, and some models and electrical toys. Messrs. Apps and Co. lent an induction coil, and a set of vacuum tubes mounted on a revolving table and driven by a small electric motor. The Gulcher Electric Light Co. exhibited specimens of their armatures and electric lamps. Dr. Edward Hopkinson lent a working model of an electric tram-car.

FOREIGN & COLONIAL SECTION.

Tuesday, January 17th, 1888; SIR PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., Vice-President of the Society, in the chair.

The CHAIRMAN, in introducing Mr. Trendell, said it was perhaps not altogether inappropriate that he should occupy that position, as he had latterly had a good deal to do with our own colonies, and had thus learned much which the English people were unfortunately too often ignorant of. This ignorance was now being dispelled, and a desire to know something about the colonies of other countries was succeeding it. The Dutch had probably next to England the largest number of colonies, and certainly, considering the small population, probably less than that of London, it was very remarkable that they should have colonies populated by some 29,000,000 of people, and that they should maintain a very large navy for the protection of their commercial interests. For many years we had been on the best possible terms with the Government of the Netherlands, and the Dutch Minister in this country had always done his best to maintain and preserve amicable relations on al matters connected with the Dutch colonies.

The paper read was—

THE COLONIES OF THE NETHERLANDS.

By A. J. R. Trendell, C.M.G.

The very wide and general interest awakened in all that concerns so important a problem as the settlement of distant lands in order to provide outlets for the teeming populations of European States, and to open up new markets for the manufactures of the Old World, has of late years received a considerable stimulus.

It is not the purpose of this paper to inquire how far this has been brought about by the exigencies of politics, and the cognate question of State - aided emigration, but rather to refer to the commercial and social aspects of a question which, in all that concerns it, must necessarily be one of the deepest interest to all thoughtful men. That highly successful and patriotic undertaking, the Colonial and Indian Exhibition of 1886, which owed its origin and administration to the personal efforts of H.R.H. the Prince of Wales, has no doubt had the effect of leading Englishmen to make themselves more thoroughly acquainted with the story of our colonial enterprise, to watch with ever-increasing interest these vigorous offshoots from the parent tree, and generally to think more profoundly of their marvellous growth and latent resources, and of their potentialities for the good of mankind. As Professor J. R. Seeley reminds us, "they are great communities in an early stage, and there is no reason why the names of New Zealand or Victoria should not one day sound as impressively in the ears of men as the names of England or France, Italy or Greece."

And this public interest in our own colonial enterprise, combined with the activity recently displayed by certain Continental powers in Africa, Oceania, and the Indian seas, seems to point out that the present time is a fitting one to submit a paper which, rapidly tracing the growth or decadence of the Netherlandish colonies, since Holland among the nations ranks next to ourselves in the vigour of her colonial enterprise, may afford a basis of discussion on a theme of such international importance. It is not possible, on the present occasion, to refer to those colonial territories of Holland which have passed from her sway into that of other Powers. Indeed, it is hardly necessary to point out that a paper which can only be a brief one cannot touch more than the mere fringe of a narrative of such thrilling interest and practical importance.

It will be well to begin by settling one or two points of phraseology.

By a colony let us understand a company or body of people, large or small in numbers, transplanted from their mother country to a remote region for the purpose of cultivating and inhabiting it, while they remain subject to the supreme jurisdiction of the parent State. This would exclude, for the purposes of this paper, any reference to the vast Teutonic emigration to countries under another flag (notably to the United States and our own colonies), for although Germany has been, in one sense, a great colonising power, it will not be necessary here to refer to this continued absorption of the surplus German population into the territories of other countries, with some of which Germany may possibly have little or no sympathy. The like remarks apply with equal force to the vast Chinese immigration to Australia and elsewhere.

If we fix the era of colonisation at 1492, or the date when Columbus discovered America, we exclude alike the early Scandinavian settlements in Iceland and Greenland, and the alleged discoveries of places beyond the seas, before the commencement of the 15th century, by France and Portugal.

Colonies are conveniently divided into four large classes, agricultural, mining, planting, and commercial, the Netherlandish colonies belonging to the two latter categories.

The object of the planting colonies may be said to be generally the production of certain plants which grow only in a hot climate. Hence a nation is not easily formed in such regions. Europeans are the proprietors of the plantations, but their number is small, they seldom become domesticated there, but, on account of the often unhealthy climate, either administer their plantations by a steward, spending their own revenues abroad, or remain in the colony only till they have collected a fortune, when they return to their native land. The small number of planters (for the far greater part of the population consists of natives who are employed exclusively for the cultivation of the plantations) is the cause that establishments of this kind are least able to dispense with the protection and support of the mother country.

Similarly situated are the commercial colonies, which grow up from single factories and commercial stations, sometimes peaceably, sometimes forcibly, and make themselves

centres of considerable territories. The possession of landed property in them is only a means for the promotion of commerce. The Europeans in colonies of this kind are mostly soldiers, administrators, and merchants. They are the rulers, but seldom resident landed proprietors. History shows that the hardest fate which the inhabitants of commercial colonies can suffer is to fall into the hands of commercial companies, which form at the same time Sovereign political bodies. It has usually happened that the abuses and mismanagement of these companies have obliged the governments of the mother countries to bring them more or less under their own immediate superintendence, limiting the companies to their proper function of trade.

It will be correctly inferred from the foregoing remarks that only in very exceptional cases have the natives of commercial and planting colonies been allowed to take any part in the government of them.

Coming now to the political question of the relative importance of foreign colonies, it cannot be disputed that the Netherlands hold the first place as a colonial power next to our own country. The magnificent display at the Amsterdam Exhibition of 1883 abundantly evidenced the resources and the value of the Netherlandish colonies, more particularly those of the Eastern Archipelago. The Netherlanders have been for generations, with characteristic industry, steadily and persistently developing their colonial territory, until they now rule over a population whose number is to that of the mother country as six to one. This great result has been achieved in face of the very serious political vicissitudes to which the Netherlands have been subjected, and in spite of the stern rivalry of the Spanish and Portuguese. It is very significant to remark, in this context, that the Netherlanders maintain, in their East Indian possessions alone, upwards of 30,000 men, while for the protection of their commerce at least sixty vessels of war cruise in the Indian waters.

Thus the splendid colonial dominion, built up by the farseeing statesmen of the Netherlands in their struggle for colonial supremacy in which they wrung these settlements from other nations, remains amply protected by their armies and their fleet; and although it may be difficult to define the exact authority which they now exercise in certain colonies, the fact remains that Holland has obtained the recognition of all her possessions in the Indian Archipelago, with full liberty to extend them in that region. She has taken advantage of this to the fullest extent, since between 1824 and 1882 Holland entered into no less than 385 treaties with native chiefs within this area.

The colonies of the Netherlands now embrace an area of 766,137 square miles, with a population of nearly 29,000,000. And this vast colonial empire in Asia, inferior only to that of England, has, as already mentioned, been built up by constant struggles during two centuries; but of late years the stress of conflict has given place to a persevering diplomacy which has never in these regions clashed with the aspirations of any other European power.

It is impossible, within the narrow limits of this paper, to trace in anything like detail the remarkable commercial development of Holland, which is so bound up with that of her colonies. I need not say that the Netherlands have, since the fifteenth century, been subject to political vicissitudes of a most unusual nature. It will be remembered that they were annexed to Burgundy in 1436, to Austria through marriage in 1477, and on the union of the Spanish and German crowns early in the following century they passed under the dominion of Spain.

The establishment of the Inquisition by Philip II. was the signal for a series of attempts on the part of the inhabitants of the Low Countries to regain their independence, and was the foundation of the bitter hostility between the two nations. The Netherlanders had for many years past been the carriers of merchandise between Lisbon and the East Indies, and when Philip, in 1584, closed that port to them, and ten years later seized a number of their vessels in harbour, their trade with India was practically ruined. They had, therefore, no alternative but to submit, unless they could find, as they soon succeeded in doing, some means of evading the edict.

It is from this date that the colonial empire of the Netherlands begins. Far from being daunted by such rigorous measures, the sturdy Netherlanders adopted effective means for reaching the East Indies on their own account. It is to the enterprise and patriotism of the "Company of Remote Parts," constituted towards the end of the sixteenth century by certain merchants in Amsterdam and Antwerp, that Netherlandish colonisation owes its origin, —and the name of Cornelius Howtmar will always be honoured alike as the pioneer in this great work, and commander of the small fleet of 1595, whose discoveries have now attained to such magnificent proportions.

Although the success of this expedition was not so great as was anticipated, the Netherlanders, with the characteristic perseverance of the Low-German race, redoubled their energies until a result was attained which must have out-distanced their fondest expectations. Henceforth we have to chronicle a most brilliant series of successes in all directions. Starting from 1602, when their East India Company was chartered, we find the Netherlanders in 1605 expelling the Portuguese from Amboyna, and in 1607 they took possession of the whole Molucca group. About the same time they seem to have established themselves in Java, for we read of a Netherlandish governor being at Bantam in 1611, in which year also they managed to obtain a monopoly of the trade with Japan. In 1619 Batavia, the capital of Java, was founded.

Encouraged by their good fortune in the East, the Netherlanders turned their attention to the New World, a West India Company being chartered in 1621, and the settlement of Berbice was founded by them in 1626. Following up their success, they made some extensive conquests in Brazil in the ten years from 1630 to 1640. These conquests, however, they lost in 1642, and in 1661 formally sold their "rights" in that country to Portugal. In 1634 they expelled the Spaniards from Curaçoa and founded Nicoria in Guiana. Surinam they acquired in 1666.

To return to their East Indian possessions, we find that in 1623 they expelled the English from the Spice Islands, and in the following year occurred the regrettable massacre of Amboyna, in which several of our own countrymen were killed. An interval of quiet commercial progress seems now to have intervened, for the next feat of the Netherlanders was to expel from Malacca the Portuguese, who had just themselves managed to shake off the Spanish yoke. This occurred in 1641, and in two years' time we first hear of the Netherlanders in the important island of Borneo.

Again attacking their old foes the Portuguese in 1660, they drove them from Celebes, but were themselves expelled from Formosa by the Chinese in 1661. They, however, successfully attacked the Portuguese settlements on the Malabar coast in 1663, and obtained their first footing on the west coast of Sumatra in 1664; after which date they appear supreme, at all events as against the Portuguese, in the Eastern Archipelago.

A powe whose share in maritime exploration and whose mercantile supremacy two centuries ago were matters of history, might naturally be expected to attain to colonial predominance among the nations. But it is none the less remarkable that this should have been based on such secure foundations by so small a power, during the stress of European turmoil. And it is evident that the old repute of Netherlandish statesmen is well sustained at the present day by the able advisers of the King of Holland, since the colonies of this nation continue to be administered with all the vigour which characterised their early youth.

That this little country, with a population less than that of London—such a mere atom in point of area of the earth's surface—should have attained to such a magnificence of maritime development, intensifies the political axiom that in her navy a nation ever has alike the surest defence of her shores, and a factor of incalculable strength in the path of commercial progress.

The greater part of the commerce of the Netherlandish East Indies is with the mother country, and that with other nations is comparatively small. The principal foreign countries trading with these colonies are Great Britain, France, the United States, and Germany. Sugar, coffee, tea, rice, indigo, and tobacco are the principal articles of export. One half of the rice is shipped to Borneo and China, but nearly four-fifths of the other exports go to the Netherlands. Formerly, as is well known, the monopoly was of a very close character, so much so, that the planters persistently destroyed a great portion of the spice crop in order to prevent its falling into other hands, and to keep up prices. But this was previous to the treaty of peace with England in 1824, by which Holland finally abandoned her monopoly of trade. This, however, did not prevent her maintaining, till 1874, a system of differential duties in Java, which hampered the development of trade with foreign countries.

The East Indian possessions of Holland comprise Java and Madura, with Sumatra, portions of Borneo and New Guinea, the Riow Lingga Archipelago, Banca, Billiton, Celebes, Timor, the Molucca Archipelago, and the small Sunda Isles.

Java, which is about the same size as Ireland, is by far the most important of these East Indian colonies. It is the granary of the Asiatic Archipelago, and is supposed to be capable of supporting many times its present population, as not one-half

of its surface is yet under cultivation. The climate is healthy, except in the marshy regions of the north, and the scenery is both grand and picturesque. The island is traversed throughout its entire length by a chain of mountains of moderate elevation which slope gently to the sea; these are crowned by volcanoes—which indeed constitute a prominent feature of this region—eight to twelve thousand feet high; the rocks are chiefly basaltic, and the soil is extremely fertile, the island, like the rest of the group, being covered with a sombre vegetation and luxuriant forests.

Java has long had an unenviable notoriety for the eruption of its volcanoes. The volcanic band appears on the north-eastern point of Celebes, and suddenly shifting 200 miles to the east, it flares up in the Banda volcanoes, and going westward traverses the islands until it seems to die out on Barren Island, in the Bay of Bengal.

A permit from the Governor-General is necessary before any European can reside in the island. Travellers and scientific explorers, however, seem to be received by the Netherlandish authorities with every courtesy and consideration. Notwithstanding the love of liberty, exceptionally strong among the Low-German family of the great Teutonic race, it is surprising to find that it was only on the 1st January, 1860, that slavery was abolished by law in Netherlandish India, the owners receiving monetary compensation.

Java, the finest of those islands which have been styled a girdle of emeralds strung along the equator, is administered politically and socially on the culture system established by General Van den Boosch. This system consists, in the main, of the official supervision of the labour of the natives in such a manner as, while it leaves them enough food, allows of the export of the largest quantity of colonial produce for the European market.

Netherlandish India is under the control of a Governor-General, who resides in Java, and is assisted by a council of five members, of Netherlandish descent, who have no share in the executive, but whose duties are partly legislative and partly advisory. There is complete religious toleration in Java, the religion of the natives being Mohamedanism, with an admixture of Buddhism, and it is interesting to record that the Malays of the island have a sacred language containing a number of Sanskrit words. This points conclusively to its Hindu sovereigns of the 15th and earlier centuries; indeed, Hindu monuments are found of very great antiquity, as well as ruins of considerable cities and temples of most substantial architecture and of rich design. The modern Javanese, who also inhabit Madura and portions of Sumatra, use a language, or rather two kindred dialects, known as Javanese and Kawi, for which they adopt a native character in writing.

The early history of Java, under its Oriental rulers, is lost in the mists of antiquity, but it is certain that it was conquered from its Hindu rulers by the Arabs about 1478, that the Portuguese settled on the island in 1511, and the Netherlanders in 1575, their rule gradually supplanting that of the Portuguese. Java was captured by England in 1811, and held for five years. The treaty of 1816, which settled the eastern possessions of England and the Netherlands, retransferred the island to the latter country, which has held it ever since. The population is now over 19,000,000.

The crops of Java are, broadly speaking, as follows:—Rice is the principal grain, and is grown all along the coast; coffee is raised in the uplands, and its culture, with that of sugar, has greatly increased within the last few years. Indigo, tobacco, tea, cinnamon, maize, and other dry grains, pulses and vegetable oils, with cocoa and sago, are the chief minor products. Dense forests of the teak tree cover many of the hills. The minerals comprise iron, tin, salt, sulphur and nitre. The revenue of the island yields a considerable surplus after all the expenses are paid. The only export worth mentioning from Java to the United Kingdom is sugar in an unrefined state, and the staple article of British home produce imported is manufactured cotton, including cotton yarns, but there is reason to believe that in this, as in other directions, the English manufacturer is being hard pressed by his continental rivals, and it is an undoubted fact that we take more from Java than we send out there. The fauna of Java contains many species peculiar to that island, among them being a rhinoceros which is not found in Sumatra or Borneo.

The date of the Netherlandish occupation of Java is usually reckoned from the foundation of Batavia in 1619. The first governor, however, arrived at Bantam in 1611, as previously mentioned, and obtained leave from the King of Jacatra to build a fort and establish a factory.

Sumatra, or, as Marco Polo calls it, *Java Minor*, the adjacent island on the north-west, is divided obliquely by the equator into almost

equal parts. It is nearly 1,000 miles long, and on an average about 160 miles broad, and the population is believed to exceed 5,000,000. A chain of high mountains, many over 10,000 feet high, runs through the whole extent of the island. Among these ridges are extensive plains of great elevation, forming not only the most temperate, but the most valuable as well as the best inhabited parts of the island. These are interspersed with large and beautiful lakes. The soil is generally fertile, like that of Java, although a great part of the island is covered with impenetrable forests. The principal articles of export are pepper, gold dust, copper-ore, sulphur, and camphor from the north, nutmegs, cloves, and mace from Benkulen, and coral, benzoin, gutta-percha, tin, iron, tobacco, rice, and sago, from other parts of the island. Many of these articles are brought by natives to the ports and bartered for goods of European manufacture. Pepper is by far the most important of these products, immense quantities being annually exported.

Sumatra is rich in mineral and fossil productions, and has long been famous for gold, which is still procured in considerable quantities from Mount Ophir, in the extinct volcanoes adjacent to that mountain, which is situated at the equator, are found granite, marble, porphyry, and petroleum. The island possesses also mines of iron, copper, and tin. Sumatra, like the rest of the Sunda islands, is singularly rich in its flora and fauna. The elephant, rhinoceros, tiger, bear, and orang-outang roam in its dense forests, and the crocodile wallows in its shallow rivers; buffaloes have been domesticated as live stock, and swine and goats are both domestic and wild. The upas tree and the gigantic *Rafflesia*, a parasite growing chiefly on the bark of a species of *Cissus*, are among its vegetable curiosities, while its insect life is gorgeous in the extreme. A portion of the island is peopled by a race of undoubted Arab descent, and the survival to the present day of the manufacture of gold and silver filigree and other Oriental art-work, together with the construction of the houses on posts, all point to the ultra-Gangetic origin of this ancient race. It seems reasonable to infer from these facts that the Arab conquest of Java, which took place in 1478, extended also to some of the neighbouring islands.

The Netherlandish sovereignty which has now practically spread itself throughout the island dates from a settlement on the west coast in 1664, but it is not easy to trace the successive steps by which this rule extended itself. In point of fact, it is not actually recognised by the natives over large tracts of the island. Constant skirmishes take place to this date, between the Netherlandish troops and the islanders in this district. In 1685 England established herself at Benkulen, but the settlements thus founded, together with others which had been subsequently captured, were all ceded to the Netherlands, in exchange for possessions in Malacca, by the treaty of 1816, together with the island of Billiton, which England had obtained in 1812 by cession from the Sultan of Palembang, one of the reigning princes of Sumatra.

The gorgeous beauties of the tropics are nowhere more resplendent than in Sumatra. I may be excused if I quote here Wallace's graphic description of a tropical morning which well applies to all the beautiful islands of this Archipelago. "Up to a quarter-past five o'clock," he says, "the darkness is complete; but about that time a few cries of birds begin to break the silence of night, perhaps indicating that signs of dawn are perceptible in the eastern horizon. A little later the melancholy voices of the goat-suckers are heard, varied croakings of frogs, the plaintive whistle of mountain thrushes, and strange cries of birds or mammals peculiar to each locality. About half-past five the first glimmer of light is perceptible; it slowly becomes lighter, and then increases so rapidly that at about a quarter to six it seems full daylight. For the next quarter of an hour this changes very little in character; when suddenly the sun's rim appears above the horizon, decking the dew-laden foliage with glittering gems, sending gleams of golden light far into the woods, and waking up all nature to life and activity. Small birds chirp and flutter about, parrots scream, monkeys chatter, bees hum among the flowers, and gorgeous butterflies flutter lazily along, or sit with full expanded wings exposed to the warm and invigorating rays. The first hour of morning in the equatorial regions possesses a charm and a beauty that can never be forgotten. All nature seems refreshed and strengthened by the coolness and moisture of the past night. New leaves and buds unfold almost before the eye, and fresh shoots may often be observed to have grown many inches since the preceding day. The temperature is the most delicious conceivable. The slight chill of early dawn, which was itself agreeable, is

succeeded by an invigorating warmth, and the intense sunshine lights up the glorious vegetation of the tropics, and realises all that the magic art of the painter or the glowing words of the poet have pictured as their ideals of terrestrial beauty."

A recent writer in the *Journal of the Asiatic Society* calls attention to the vast coal-fields of very superior coal on the west coast, and gives his unqualified opinion that there still remains in the rich resources of Sumatra a vast field for European capital and enterprise.

The large island of *Borneo*, in which the whole British Islands might be set down, and still be surrounded by a broad sea of forests, has an area of 280,000 square miles, being about 850 miles in length by 600 in breadth, only partially belongs to Holland, which country, however, claims jurisdiction over rather more than two-thirds of its area. It is administered politically by the two Dutch Residencies of of west, and south, and east Borneo, aided by the native chiefs. In my work on "Her Majesty's Colonies," I had the advantage of consulting that eminent authority, Sir Rutherford Alcock, on general questions concerning this magnificent island, and the information here given, as to its occupancy by European nations, is mainly derived from the particulars with which he was good enough to furnish me.

The earliest Netherlandish and English navigators all saw a splendid property in Borneo, and so far back as the reign of Queen Elizabeth, companies of mercantile adventurers from this country were largely and successfully engaged in preventing the total absorption of the rich trade of the Eastern Archipelago by Portugal, Spain, and Holland. These powers had in succession claimed the territory in all the islands of the Archipelago and the Straits, including Malacca, and in 1602 the States-General of the Netherlands, in pursuance of a monopolising policy, consolidated their various companies, and created the "Netherland and East India Company," already referred to, the first of those great joint-stock companies, the result of whose enterprise proved to be the turning point in the commerce of Europe. It was the spices of the Moluccas, especially the nutmegs and mace, the taste for which, in the Middle Ages, had rapidly spread throughout Europe, which wrought this revolution; and this spice trade, more than any other, was the great prize for which the Netherlanders did vigorous battle, and in the end drove the Portuguese out of the field.

Many of the islands from Manila to Java, forming the Borneo group, with their tropical fertility and valuable products, possessed an amount of trade and prosperity which could not fail to attract attention in the 16th century, a prosperity of which it is sad to reflect there is now but little trace. Our early navigators leave no doubt on this subject. Captain Daniel Blackman, in 1714, relating his voyage to Borneo, alludes to a considerable trade with China; and Mr. J. Hunt, in a report to Sir Stamford Raffles in 1812, says that when the Portuguese first visited Borneo, in 1520, the whole island was in a most flourishing state. The number of Chinese that settled on her shores was immense; the products of their industry, and an extensive commerce with China, in junks, gave her land and cities a very different aspect from her appearance at this day, and the princes and courts of Borneo exhibited a splendour and displayed a magnificence which has long since vanished. Mr. Hunt attributes this decay of prosperity and commerce to the direct action and mistaken policy of the Portuguese first, and subsequently of the Netherlanders themselves.

In the year 1643, the Netherlandish occupation of Borneo may be said to have had its commencement, for in this year the States-General concluded a commercial treaty with the Prince of Banjermassing, and erected a fort and a factory at the village of Tatis. Subsequently in 1778 they erected other forts and factories, gradually extending their sway by persistent efforts over about two-thirds of the island. The other portions of Borneo belong to the Sultan of Brunei, the Rajah of Sarâwak, with the British North Borneo Company in the most temperate region —the extreme north of the island.

In former times a kingdom of Borneo appears to have extended over the whole island and part of the Philippines, and tradition assigns to its monarchs a Chinese origin. It is only of late years that the interior has been explored. Of the rivers we have only a partial knowledge of the lower parts of their course. A range of mountains of crystalline formation on the north-east coast extends probably throughout the island, which is the only one in the whole Archipelago in which diamonds have been found.

The ethnology of Borneo presents many interesting features. The population is probably between two and three millions, divided into Malays, Dyaks, Papuans, Chinese and Bugis, and there are also a few Javanese,

Hindus, and Arabs, the latter being perhaps the descendants of the Arab invaders of the Archipelago towards the end of the fifteenth century.

The Malays possess great hardihood, but are extremely dangerous from their covetous and vindictive disposition; they are the predominating and most civilised race on the coast; in fact, the Malays proper inhabit almost all the coast regions both of Borneo and Sumatra. They all speak the Malay language, or dialects of it, use the Arabic character in writing, and profess the Mohamedan creed. The Dyaks are a finely formed race of yellow complexion, notorious for their savage customs and cruelty, as well as for their piratical habits. Ethnologists consider that they were unquestionably the earliest inhabitants of the island. The Papuans, likewise, have probably been in the island from a remote antiquity; they occupy the most inaccessible forests and retreats, dwelling principally in caves and on trees. The Bugis, chiefly emigrants from Celebes, live in amity with the Dyaks, and have become rich and powerful by commerce and piracy. Trade is in their hands, and the exports, mainly passing through the Netherlanders, consist of dye woods, nutmegs, camphor, cinnamon, pepper, ginger, rice, cotton, and gamboge. The mineral productions are gold, antimony, iron, tin, and zinc, besides crystals and diamonds. Gold is found in grains on the hills, and there are immense forests of iron-wood and teak.

New Guinea until quite recently had been regarded as "No Man's Land," although Holland was known to have had for some time settlements on its western shores. But little was known of this magnificent island till quite modern times, due partly to the difficulties and dangers of the navigation of Torres Strait, but principally to the exclusiveness of the Netherlanders, who, having acquired great interests in the Spice Islands, did not encourage any access to places east of them. New Guinea is divided, for political purposes, by a purely scientific frontier, the 141st meridian of east longitude, all to the westward of this line being claimed by the Netherlands.

The island was discovered by the Spaniards in 1528, and it is difficult to determine under what conditions the Netherlands acquired their settlements in the island, but in 1828—just three hundred years after its discovery—the commander of the Netherlandish vessel, the *Triton*, took possession, in the name of his government, of all territory westward of the 141st meridian, but after a few years the unhealthiness of the climate caused the settlement to be abandoned. In 1835 the commander of another Netherlandish ship surveyed other parts adjacent to this earlier settlement, and on these efforts at colonisation, the Netherlands government apparently bases its claim to the 150,755 square miles of New Guinea now in its possession, having a population of some 200,000. This territory belongs for political purposes to the Netherlandish Residency of Ternate, in the Moluccas.

The position of this island, which is only a little smaller than the colony of New South Wales, being about 1,500 miles long, and with a breadth of 200 to 400 miles, renders it of great strategic importance. It forms, as it were, a link connecting the Indian Archipelago on one side, with the Polynesian group on the other.

The climate of New Guinea is extremely unhealthy on the sea coast, even the natives suffering there in the wet season. The island is, in fact, remarkable for its humidity, owing doubtless to the equatorial stream of vapour and to its high mountains, which come close down to the sea, while in the interior there are still loftier ranges covered with perpetual snow. It is clear, therefore, that the only colonisation, in a proper sense, of this island must take place on the high grounds.

On the west coast, that is in the portion occupied, or rather claimed, by the Netherlands, there are numerous Malay settlements, but the bulk of the inhabitants are negroes, though not precisely of the African type. One of the greatest difficulties with which settlers in New Guinea have to contend is the want of real chiefs, authority resting very much with the sorcerers, who, when the chiefs lose their influence, or their lives in the wars, arrogate to themselves tribal power. The natives are not such savages of exceptional cruelty as they have been represented to be, since Mr. Chalmers, who has travelled many hundred miles into the interior and has lived for twenty years amongst them, considers the inhabitants of New Guinea to be "semi-civilised savages, very impulsive, easily won, who can do terribly cruel things, but who can be tender and sympathetic."

The cultivation of the soil is largely carried on by natives on the coast, who terrace the hill sides for the purpose of planting their yams and sugar canes; and the Papuans show generally a knowledge of husbandry rare among savages, having a systematic plan of turn-

ing over the soil with sharp-pointed sticks so effectively that it resembles a well-ploughed field, in which they cultivate rice, maize, yams, and other tropical productions. The available products of the country for commercial purposes are the sago-palm, the sugar cane, native flax, and cedar. The sago promises to be a most valuable export; it is said that thousands of tons are available. Much of the timber is of gigantic size, and tobacco is a natural production of the country, being cultivated by the mountaineers. Pottery and rope-making are the principal native manufactures. All business between the Papuans and whites is carried on by a system of barter, ordinary twist tobacco being the most convenient medium of exchange, but knives, tomahawks, pieces of iron hoop, beads, and looking-glasses are in great demand.

The religion of the natives consists in the belief in some superior being who dwells in the mountains. Cremation is practised among some of the tribes, as well as circumcision, and it has been thought from their poetry, legends, and customs, that this interesting people may have fallen from a higher civilisation. Here again we see the outcome of possible Arab influences.

The mammals indigenous to this country resemble those of the neighbouring continent of Australia, but there are, in addition, the wild pig and several marsupials unknown on that continent. The birds, like the mammals, are of the Australian type, though New Guinea has many species not represented in Australia. Among these are the birds of paradise, at least twenty-five species of which have been discovered in this island and the lands in the immediate vicinity. Dr. Robert Brown observes that, with the exception of one very curious species discovered by Mr. Wallace in the Moluccas, all the birds of paradise are found in New Guinea or on the contiguous islets, and therefore on lands which have probably been connected with the principal island at no distant date. Most of these birds are found in the Netherlandish section of the island, or, to speak more precisely, on the north-west peninsula.

It is remarkable that these gorgeously plumaged birds exist only in the luxuriant tropical forests of this island and the neighbouring islets, and as New Guinea is still in a large measure virgin soil, it affords a wide scope for the energies of the naturalist Nowhere in the world are parrots and pigeons so lovely as they are here. Many of the fruit doves are strikingly beautiful, and the great crested pigeons rival in size the largest of our game birds. Parrots of many species, including the large black and white cockatoo, lories, and little crested green parrokeets, scarcely larger than our finches, are very abundant, while several varieties of the kingfisher of most brilliant hues are as resplendent as the gorgeous insects for which New Guinea is remarkable.

Quite recently exploring parties, following the courses of the large and probably navigable rivers, have found in the interior plains of great beauty and fertility. It does not appear that the Netherlands Government has taken much part in these explorations, which are mainly the results of the enterprise of Australian and German men of science.

The triple occupation of this magnificent island is a source of great heart-burning to our Australian cousins, the Queenslanders especially, and diplomacy has an important task in the future in so controlling conflicting interests that the civilisation and development of the resources, of this great island may not be marred by international jealousies.

Banca, a small island between Borneo and Sumatra, in area about 5,000 square miles, is well known for its excellent tin, principally obtained from the north end of the island Many thousand tons of this metal are annually exported, and obtain a high quotation in our own metal markets. It is a valuable commodity to Holland, since it is easily worked, being found in a black alluvium near the surface, and it is obtained by Chinese labour and is consequently cheap. Other valuable minerals are found in this island.

The capital of Banca is Muntok. It is a very unhealthy town, facing the Strait of Banca, and having the low swampy shore of Sumatra opposite. The Netherlandish troops suffer severely from the Banca fever, one of the most dangerous diseases with which man is afflicted. During the time that Banca was occupied by British troops in the early part of this century it proved fatal to nearly the whole of the garrison. All who have suffered from this terrible fever are subject to severe recurrent attacks at the full and change of the moon. To be sent to Banca from Java is looked upon as one of the hardest lots which fall to a soldier.

Banca, the permanent population of which at the end of 1886 was 74,716, is believed to yield nothing but tin, since the rice, which is the food of the Chinese miners, arrives regularly

from Java. The rivers of this unhealthy region are infested by immense crocodiles, which from the scarcity of the usual food of such reptiles become exceedingly dangerous, even attacking boats on their course along the rivers. Most extraordinary tales are extant concerning their ferocious onslaughts.

The Straits of Banca were once the resort of numerous pirates, but the activity of the Netherlandish cruisers has now removed this pest to commerce.

Celebes is an island of most irregular shape, resembling in form a huge grasshopper, and consisting of four peninsulas united in a common centre, no point being more than fifty miles from the sea, although the island is 500 miles from the extreme north to the extreme south. It was discovered, about 1525, by the Portuguese who were attracted thither by rumours of the gold found in the island, and, indeed, this metal, in point of fact, is still found there.

The Netherlanders have possessed settlements here since they expelled the Portuguese in 1660, and have gradually acquired a protectorate over the whole island, the nominal sovereignty being vested in about a dozen kinglets more or less under the direct influence of Holland, the Netherlandish capital being Macassar, in the south-west peninsula. This town was created a free port in 1847. Although it has been so long in the occupation of Holland, it is believed that, unlike other islands of the Archipelago, Celebes has not been a financial success.

Celebes was taken by the British in 1812, but restored to Holland by the treaty of 1816. The religion of the inhabitants is Mahomedanism, although some form of Hinduism is supposed to have been the primitive creed. The existence of the former religion may be traced to Arab invasion. The heat of the island would be excessive were it not modified by abundant rains. No island of the Eastern Seas has more varied scenery, or a more fruitful soil—beautiful lakes and fine grassy stretches of level ground frequently occurring. Fruit and flowers grow in all seasons, and the trees are always green. Jasmines, roses, carnations, and other beautiful flowers thrive without culture ; orange trees and citrons occur everywhere in the lowlands, with mangoes and bananas ; cotton trees cover the extensive plains. The minerals are gold, iron, and salt.

The inhabitants raise a great number of cattle and have excellent breeds of horses ; the oxen are larger than those of Europe, and the forests abound with large herds of deer, wild hogs, and a great variety of large and ferocious monkeys. The animal life of Celebes is altogether very remarkable, several species of mammals, and at least 128 land birds, being fonnd in this island alone, the insects and reptiles showing an equally remarkable isolation. The principal articles which Holland obtains from the island are gold, ivory, rice, sandal-wood, ebony, cotton, camphor, ginger, pepper, and pearls, but indigo, coffee, and tobacco are also grown.

The population of Celebes is believed to exceed 2,000,000, but less than half of these are reckoned as being under the direct control of the Netherlands Government in their two Residencies of Celebes and Menado. In the interior live a people called by the coast tribes Turaju, who are represented as "head hunters" and even cannibals. The Bugis are what the Malays were when the Portuguese first came to the East—the great traders and navigators of the archipelago. They coast along many thousands of miles in their vessels of 40 or 50 tons burthen, carrying to all the islands English calicoes, and cotton goods of their own manufacture; also Chinese gongs and large quantities of arrack. They bring in return tortoiseshell, mother-of-pearl, shells, pearls, birds of Paradise, and trepang, which appears to be the Malay name for all kinds of Holothurians, or sea-cucumbers. There are yearly shipped from Macassar, for the use of the cooks in China, at least $1,000,000 worth of this glutinous food, so relished by the Celestials. The languages spoken by the Bugis are Bugis and Macassar, with dialects. They are all said to be Mohamedans.

The ancient inhabitants of Celebes, according to De Cauto, were accustomed to burn the dead and collect the ashes, which they interred in fields, in which they erected mortuary monuments. The mountains are much more connected into chains than those in Java, the loftiest peak in Celebes rising to 8,200 feet.

The *Moluccas*, or Spice Islands, constitute an archipelago between Celebes and New Guinea, and are conjectured to contain a population of about 350,000 ; they have an area of over 42,000 square miles. The islands are divided into the Great and Little Moluccas. The former include Gilolo, Ceram, Amboyna, Barda, Buru, Morty, and the latter Ternate, Motir, Matchiar, Batchisn, and Tidor.

This archipelago was discovered by the Portuguese about 1511, and held by them

secretly until the arrival of the Spaniards, who claimed the islands till 1529, when the Emperor Charles V. yielded them to John III. of Portugal for a large sum of money. Holland conquered the Moluccas in 1607, and has held them ever since, except in 1796, and again from 1810 to 1816, when they were subject to the English, passing again, however, to the Netherlanders under the treaty of Paris.

When the Portuguese first arrived in the archipelago, they found, no doubt to their surprise, a thriving colony of Arabs already established there, the prevailing religion being Mohamedanism, mingled, however, with paganism. This seems further to establish the fact that the Arabs, who we know conquered Java in 1478, spread themselves throughout the whole archipelago. The inhabitants appear to have been rather severely dealt with, both by the Portuguese and the Netherlanders, who discouraged the free cultivation of the land and the establishment of manufactures, as well as all attempts on the part of the natives to trade on their own account with other nations, or to interfere in any way with the extremely valuable yield which the produce of the spice plantations, especially cloves, proved to be to the European markets.

It is interesting to note here that cloves first appear in history between A.D. 175 and 180, being mentioned in a law passed in the reign of the Emperor Aurelian as an article of commerce from India to Alexandria, *viâ* the Red Sea, then the chief highway of Eastern trade. They did not, however, come by a very direct route, as their first stage was to the Malay peninsula where they passed into the hands of the Telingas, who carried them to Calicut, at that time the capital of the ancient kingdom of Malabar. Thence they were transported to the western shores of India, and shipped across the Arabian Sea and the Red Sea to Suez, eventually reaching Cairo. The cost of such a transit so increased the original price, that before the doubling of the Cape of Good Hope cloves fetched in England as much as thirty shillings a pound. Although such a favourite condiment throughout the civilised world, the natives of the Moluccas never eat cloves in any form, and there is no reason to suppose they ever did.

The main settlements of the Netherlanders are at Amboyna and Ternate, which latter residency has jurisdiction over the Netherlandish portion of New Guinea, the chiefs of the other islands being more or less tributary to these residencies. It is to the southerly or Amboyna group of the Moluccas that the Netherlanders some quarter of a century after they occupied these islands and obtained the monopoly of their spices, found it advantageous to transplant the spice trees. By their agreement in 1638 with the then King of Ternate and the petty rulers of the other islands, it was stipulated that in consideration of an annual sum all the spice trees on the islands not in the direct occupancy of the Netherlands should be rooted up and that no more should be planted. To insure the fulfilment of this agreement, three strong fortresses were erected in Ternate and nine others in other islands, while to prevent smuggling, the Governor of Amboyna made a progress through the Archipelago every year with from twenty to fifty ships.

As the spice trees sprang up in the prohibited districts they were destroyed every year as far as possible, but being the indigenons growth of the islands, nature declined to obey the edicts of the States-General in the same way as the natives, and very considerable smuggling went on until the trade was thrown open in 1824.

Amboyna, besides being the principal emporium of the Spice Islands, is also the island in which the clove tree is most plentiful, the nutmeg tree growing principally in Banda. The other productions of the Moluccas, which are distributed over the islands, are sago, cocoas, sugar, coffee, bread fruit, tropical fruits in abundance, iron, ebony, teak, with the yield of many other rare and valuable trees. Everything, however, except fruit, is very dear. The island is, generally speaking, healthy, and is capable of raising many tropical products which are not now cultivated, the policy of the Netherlanders being to restrict the cultivation to cloves alone. About a million pounds weight of this spice are believed to be annually exported.

With reference to the fauna of Amboyna it may be mentioned that fishes abound, Dr Bleeker having described over 780 species, about the same number as those inhabiting all the seas and rivers of Europe.

The capital has the same name as the island itself; it is well built, and defended by a citadel. The spacious streets are planted on each side with shrubberies, and one of them is adorned throughout its entire length with a double row of nutmeg trees.

Shortly after the Netherlanders, in the early

part of the 17th century, took Amboyna from the Portuguese, the English erected some factories there, and the dispute between the two nations led to that lamentable event, the massacre of Amboyna, in which ten Englishmen with their *employés* perished, the Netherlanders seizing their effects and estates, and also the factories in the adjacent islands. Neither James I. nor Charles I. took any steps to obtain satisfaction, but Cromwell, with characteristic vigour, obtained from the United Provinces the sum of £300,000 as a small compensation for an incident due no doubt to the unauthorised action of an over-zealous governor, and greatly regretted by the States-General.

Banda, as already mentioned, is the principal home of the nutmeg tree, and gives its name to the group of islands lying east of Celebes. All these islands are thickly wooded with fine plantations of nutmegs, cocoanuts, and bananas. Entirely cut off from the civilised world, the islands, which are described as exceedingly lozely, are even destitute of the means of subsistence for their own inhabitants, as nature, which has lavishly bestowed upon them natural groves of spices, has denied them articles of immediate necessity. It is estimated that Banda alone could produce enough nutmegs and mace for the supply of the whole world, so favourable is the soil for the nutmeg tree, and so profuse is the yield.

Ceram is the largest island of the Molucca group, having an area of about 5,000 square miles. The whole island is really one great mountain chain, which sends off many transverse ranges and spurs, some of the peaks attaining an elevation of 5,000 to 10,000 feet. Over the sides of these mountains stretches one continuous and unbroken forest. A great part of the island is yet unexplored, nor is it likely to be so at an early date, since the Alfuru who inhabit the mouutains are among the savagest races known, one of their customs being that a young man must cut off at least one human head before he can marry. The whole interior of the eastern half of the island where this head hunting prevails is one unchanging scene of endless and savage strife. Mr. Bickmore saw in Ceram many thriving groves of cocoa nut palms, and observes that the good results already attained show what enormous quantities of the produce of these trees might be shipped yearly from this island alone.

The Netherlanders rule these ferocious natives necessarily with a strong hand, and keep them by force from leaving their mountain fastnesses, from which regions their rajahs now come down from time to time to pay their allegiance to the Netherlandish authorities.

The vegetation of Ceram, like that of the other spice isles, is luxuriant in the extreme, some trees of the sago palm being a hundred feet high. Sago is the principal product, being obtained from the pith of two or three species of palm, such as *Metroxylon Rumphii*, *Metroxylon læve*, &c. This pith is washed out and precipitated from the fibrous mass, leaving a reddish brown starch, known in commerce as raw sago. This, though not so pleasant to the eye, contains a pleasant flavour altogether wanting in the white or "refined" article. The inhabitants of the coast are of Malay origin, and carry the produce of their extensive fisheries to the Sunda Islands and Singapore in their large praus.

Ternate.—The seat of the Sultan of Ternate, who is nominal ruler, is also the capital of the second Netherlandish Residency in the Moluccas Group; it is a small island west of the large island of Djailolo or Gilolo, and has a population of about 100,000, and is principally remarkable for its volcano, at the base of which the town of Ternate is situated.

Netherlandish West Indies.—These contrast strongly in importance with the magnificent possessions which Holland holds in the East Indies. They consist of the islands of Curaçoa, Aruba, and Bonaire. with the smaller islands of St. Eustatius, Saba, and part of St. Martin. None of these are of much importance, their total area being only 403 square miles, with a population of a little over 45,000, Curaçoa, the principal of them, which was at one time a depôt of some note, having greatly declined of late years. It was originally taken, with Aruba and Bonaire, from the Spaniards in 1634. Its population is 25,208, and its area 210 square miles.

Surinam, or Netherlandish *Guiana*, lies between the English and French portions of Guiana, which, although reckoned part of the continent of South America, is really an immense island 960,000 square miles in extent, being cut off from the mainland by three of the largest rivers of South America. The first colonists of Guiana were the Netherlanders, by whom the settlements of Berbice, Demerara, and Essequibo were established in 1666, although an Englishman was the first settler in this region, having arrived there some thirty years previously. It is now a Crown colony, the governor holding his appointment direct from the Crown, but is responsible to the

Colonial Minister direct. The Governor is also president of a House of Assembly, which seems to be really a body corresponding to the legislative councils of our own Crown colonies.

Our knowledge of the country is confined almost entirely to the coast regions, the interior being covered with immense forests of impenetrable density, among which is a marvellous network of rivers and streams, which might assure to a future population a most extensive means of communication were it not that cataracts abound and that the estuaries of the rivers are choked with mud banks. Along the banks of these streams the soil is extremely fertile, yielding all kinds of the tropical products of South America; indeed, the land is rich beyond the power of exaggeration. The flora and fauna of the whole region closely resemble those of Brazil.

The natives are now only numerous in the interior, and belong partly to the leading race of the Tupí, partly to that of the Caribs, and are still for the most part independent. Possibly some future explorers may still find these ancient races existing in numerous communities on the elevated table lands of the interior, which have not yet been explored. The boundaries of the Netherlandish portion are stated by the authorities to be the River Maroni on the east and the River Curántyn on the west, the limits inland being undefined. The climate is more temperate than that of many countries under similar parallels, and the notoriety which Guiana had for unhealthiness seems to be fast disappearing since more land has been brought into cultivation and settlement. The usual temperature is from 75° to 80°. The Netherlandish settlements are chiefly on the Surinam and its branches. This river is four miles wide at its mouth, and is navigable for small craft for 120 miles, its average depth at its mouth being from 16 to 18 feet at low water mark. Paramáribo, a handsome and clean town, at once European and tropical, Netherlandish and Creole, twelve miles from the mouth of the Surinam, is the capital of the colony. It has a safe and convenient harbour, and an active commerce. The great want of the colony is Coolie labour, since it appears to be impossible for white men to cultivate the land.

Surinam produces sugar (which forms half of the entire crop of the territory), coffee, cotton, cocoa, maize, and indigo, and is said to be rich in minerals. So valuable is Surinam to the mother country that in favourable years its produce of coffee has amounted to 25 millions of pounds weight. Its present area is about 46,000 square miles, and its population 56,000, or thereabouts.

The exigencies of space have prevented any reference here to many of the smaller islands under the jurisdiction of Holland, such as the Rion-fingga Archipelago, Billiton, and Timor, the latter of which is in the joint occupation of Holland and Portugal under the treaty of 1859, although there are many points of interest attaching to all these islands.

I have endeavoured to show in this paper how a nation, having its home, like ourselves, in a most circumscribed area, has by the vigour of its daring mariners, and by the far-sighted statesmanship of its politicians, built up a colonial empire vast in extent, affluent in its resources, and of boundless capabilities for future development. The vigour of the great country in the youthful period of which I have been speaking, has been fully maintained in its maturity, and it may certainly be considered as established that Holland, which wrested these magnificent colonies by force of arms from rich and powerful rivals, even at a time when civil turmoil and foreign aggression taxed heavily her energies and resources at home, will continue to hold these vast regions with equal tenacity, and to develop them with equal skill, now that her autonomy and her inherent strength are alike unassailably secure.

DISCUSSION.

Mr. Hyde Clarke regretted that more of their friends resident in Holland were not present on this occasion, when they would have heard so high a tribute paid to their national qualities. The distinguished representative of the Netherlands in this country had endeavoured to the utmost of his power, and most successfully, to restore the ancient good feelings between that country and ourselves. With regard to the regret which had been expressed that there was not always an interest taken in the subject of the colonies, he would remark that it was scarcely possible there could be a continuous interest in so vast a subject, and it was inevitable that from time to time, as had been seen lately, there should be greater activity displayed, and more interest taken by the public, in the diffusion of knowledge on such matters. In that room one could never refer to the colonies without remembering the early history of the Society, for it was to the interest felt in the colonies at the time that the Society owed its existence. Long previous to that, the subject of the colonies, in the sense then understood, had greatly occupied writers on economic and political subjects

and one proof of the great interest in it felt in the last century was the translation of the French work of the Abbé Raynal, in five volumes, a work which still contained some of the best information with regard to some of those colonies in the last century. Coming down to our own time, without referring to other writers, most present would recollect what was done by Mr. Montgomery Martin in his history of the colonies, which materially contributed to afford information; in fact, the colonies of this country had never wanted advocates, nor had there been wanting a knowledge of what had been doing by other countries. In some parts of his paper Mr. Trendell had rendered full justice to the claims of the Netherlands, but he doubted whether at the beginning he so well defined the position of Holland. At that time certainly she was not second to England, but in advance of us in this great work of maritime enterprise. Not only in that early period did she lay the foundation of her East Indian Empire, but also secured possessions in Brazil and in the West Indies. Mr. Trendell had also omitted to notice the fact of Holland having established that colony in North America which had now become New York. At that time, therefore, Holland by no means gave way to England, though it was far behind Spain and Portugal. In connection with Sumatra, he was astonished that Mr. Trendell had not mentioned the name of Sir Stamford Raffles, though he referred to him in a subsequent part of his paper, showing that he was conversant with his administration. It was to him and his exertions that we were indebted for the Straits Settlements, and the expansion of our claims in Borneo and New Guinea which had been established in the present day. Sir Stamford Raffles took this ground, as against the monopoly of Holland, that in the beginning we were there with the Dutch, and at that time with the Portuguese and Spaniards. He did much to awaken public attention in this country to the capabilities of those islands, and to the desirability of laying the foundation of that trade which in the present day had become so great. The administration of Holland in those early days should be dealt with a little tenderly, because at that time the present doctrines of industrial and economic science were not so generally accepted as they were now. The doctrine of monopoly received general assent, and was accepted by all the great colonising states of Europe. So far from it being considered in any degree exceptional to give territorial powers to a trading company, with certain functions and jurisdiction, it was the general practice either to establish a factory by merchants or to establish a company, which, in the then state of international law, necessarily exercised jurisdiction over the territory of its factory, and of course endeavoured to extend it. The whole history of those great companies in the 17th and 18th centuries was one of territorial jurisdiction. With regard to the share of England in the Dutch colonies in certain articles, the apparent share was much less than it was in fact, because those articles were brought to the Dutch markets, where they were disposed of at the great annual sales, and thence found their way to this country. Many of the colonies of Holland came into the possession of this country, and with regard to the West Indies, although at the present moment Holland had so small a share in South America and in the West Indies, yet she was the founder of large and valuable colonies, which now belonged to England. In considering the growth of the Dutch colonies, it was necessary to take into account the political state of Europe at the time, and one circumstance which greatly favoured Holland in obtaining the Portuguese possessions was the relations between Portugal and Spain. In sixty years Portugal lost her independence, and was under the dominion of the King of Spain. In considering the position of Holland, again, it must be remembered that in the 16th and 17th centuries the population of that country was much larger in proportion to that of England than at present. For a long time Holland held a very good position in Europe, one cause of her decline being—not any fault of the Hollanders themselves, but the great expansion and growth of population in other countries, in the British Islands for example, which in Holland was perfectly impossible. Holland, in the time of Elizabeth must be compared with England at the same time, and it was a long time before the population of England and Ireland—Scotland being then a separate kingdom—attained to anything like the figures with which we were now familiar. With regard to New Guinea, the Hollanders certainly did not neglect it; there were some most valuable papers published by the Batavian Academy, of a scientific character, with regard to New Guinea, many of which he had been glad to peruse. As they were written in the language of the country, few people in this country were aware of them, but whoever wanted information on certain points was obliged to have recourse to them.

Mr. SIEBENHAAR said he had no remarks to offer as to the value of the data Mr. Trendell had given with respect to the government and management of the Dutch colonies, but he might be permitted, as a Dutchman, to make a few observations upon the present feeling in Holland towards her colonies. He quite agreed that the Dutch in the 16th or 17th century had been very successful in their dealings with the natives, but it was not correct to say that in these days they were still as powerful in the East Indies as they had been, although they still held sway there. A good example of this was the present war in Acheen, which had been going on for the last fifteen years; and which, at the commencement, was carried on with great vigour, and Col. Van der Haage, a very brave man, carried the war on in such a way that the natives were forced to submit. But since then the policy of the Government had been very vacillating. They thought it necessary to introduce

civil instead of military government, the effect of which was, that all the security established by the military power had been lost, and the natives, seeing the government was weak, had taken advantage of it. Holland lost everything she had gained, and had the greatest difficulty to maintain herself there. In former times the Dutch Government maintained its power with military severity, but of late it had been trying other experiments. A Government must either give up the idea of deriving any advantage from her colonies, or must maintain its power with great vigour. It had lately been shown by some of the best authors who had lived in the West Indies, that the Dutch policy there was a very mistaken one, and even from a philanthropic point of view it was not to be defended. The natives suffered from the efforts of those who went to accumulate wealth, and also from the operations of the Government itself, but unless it was determined to carry out the idea, to a certain extent, of driving hard bargains with the natives, and getting as much out of them as possible, it was no use attempting to make wealth from colonies at all. The present Dutch Government seemed to waver between the two ideas, and this was probably the cause of its loss of power in the colonies. At the same time this made the Government unpopular in Holland. Troops were sent to the colonies, but were not properly supported there. Insurrections arose because the natives were robbed of the fruits of their work, and then attempts were made to subdue the insurrections, but the Government did not carry out their efforts with sufficient vigour; the consequence was that no one in Holland, unless he had been in the East Indies, took any great interest in the war. Since he had been in England he had noticed that the English took a great interest in the colonial questions, but he could not say the same thing of his own countrymen. It was to be hoped that the Government would take stronger measures, and not try and carry on two policies, or the result would be that no advantage whatever would be gained from their colonies.

The CHAIRMAN, in proposing a vote of thanks to Mr. Trendell, said he had felt a great interest for many years in his literary labours, aud must congratulate him that, having produced that admirable book, "Her Majesty's Colonies," for the Exhibition of 1886, he had gone on and devoted his attention not only to our own colonies, but to the different colonies of the world. There could be no doubt that these exhibitions had attracted a great deal of attention, not only from the English people, but from other countries having colonial possessions. He remembered very well the most interesting exhibition at Amsterdam, which was a revelation even to the Dutch people themselves, and he remembered the very deep interest taken by the King of Portugal in the Colonial Exhibition of 1886. He had had the pleasure of going round with his Majesty for a great many hours, and he was most deeply interested in it, his object being to see how it would be possible or him to bring about an exhibition in Portugal of the Portuguese colonies. He congratulated the Society and congratulated the Section on having such a paper as this laid before it.

The vote of thanks having been carried unanimously,

Mr. TRENDELL, in acknowledging the compliment, expressed his thanks to Mr. Hyde Clarke for the valuable facts with which he had supplemented the paper, and which he should give careful attention to. He also expressed his very cordial thanks to Sir P. Cunliffe-Owen for his kindness in presiding on this occasion. He had been very happy to be his lieutenant in connection with several international exhibitions, in the executive management of which he had contributed that administrative skill and experience which had gained him a European reputation. As he had well said, these exhibitions had had a great effect in opening the public mind, they were great civilising influences, and vigorous exemplifications of affluent commercial enterprise. As a student for some years of these great international exhibitions, he had lately been making the colonial enterprise, not only of the Netherlands, but also of Portugal and of various other nations, the subject of careful research, if in the extended work, of which the present paper was an instalment, he succeeded in recording the almost unexampled colonial enterprise of the Netherlands—so brilliant, so stable, and so productive—in the calm and impartial spirit of the historian, the purpose of his paper had been fully attained.

SIXTH ORDINARY MEETING.

Wednesday, January 18th, 1888; the ATTORNEY-GENERAL, M.P., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, John William, 74, Oxford-street, Regent-road, Salford.

Bateman, Rev. John Fitzherbert, South Lopham Rectory, Harling, Norfolk.

Brooks, Christopher P., The Mount, Blackburn.

Buckland, Charles, 36, Piccadilly, W.

Butler, John, 11, Redcliffe-gardens, S.W.

D'Aulby, John Edward, London-house, Braintree, Essex.

Edwards, Frederick W., Fairhope, Victoria-park, Walton-on-the-Hill, Epsom.

Farrer, Sir William James, Bart., 18, Upper Brook-street, W., and Sandhurst-lodge, Berks.

Farrow, Frederic Richard, 32, Craven-street, Strand, W.C.

Fletcher, Frederick William, 9, Broad-street, Golden-square, W.

Gregory, William, Trent Valley Brewery, Lichfield.

Hankin, Major-General George Crommelin, C.B., Newlands, Guildford.

Harrison, John, 15, Tivoli-road, Crouch-end, N.

Holden, Captain H. C. L., R.A., Royal Gun Factory, Woolwich, Kent.

Hubbard, Hon. Evelyn, 38, Lennox-gardens, Pont-street, S.W.

Moseley, Joseph, Cringle-hall, Levenshulme, near Manchester.

Notley, Robert P., 35, Bucklersbury, E.C.

Richardson, William Haden, City Glass Works, Glasgow.

Robertson, G. H., 14, Milner-street, Chelsea, S.W.

Robin, F. R., 169, Albion-road, Stoke Newington, N.

Rogers, Major Richard, Fernclyffe, Battledown, Cheltenham.

Roundell, Charles Savile, M.A., 16, Curzon-street, Mayfair, W.

Smith, Gerard, M.R.C.S., The Acacias, Upper Clapton, E.

Smith, Robert Hamilton, 33, Charlwood-road, Putney, S.W.

Tamplin, Richard William, 1, Lennox-place, Brighton, Sussex.

Weir, Benjamin, Rothsay-house, Balham, S.W.

Wenborn, Major Frederick Moore, 24, Ockenden-road, Canonbury, N.

Willans, P. W., Ferry Works, Thames Ditton, Surrey.

Wilmot, Thomas James, Waterville, Co. Kerry, Ireland.

Woodland, John, St. George's Hospital, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Bell, Frederick Augustus, 14, Anerley-park, Anerley, S.E.

Fegen, Charles Milton, M.R.C.S., L.R.C.P., care of Captain Fegen, Albany-street, Bedford.

Harrison, Thomas Henry, 22, Granville-villas, Earls-field-road, Wandsworth, S.W.

Levy, B. W., 25, Pembridge-gardens, Notting-hill, W.

Martin, John Biddulph, 17, Hyde-park-gate, S.W.

Nichols, Daniel Cubitt, 3, Howard-street, Strand, W.C.

Savidge, Frederic William, Stretham, near Ely.

Stretton, Clement Edwin, Saxe-Coburg-street, Leicester.

The papers read were—

PROPOSAL FOR A POSTAL BALLOT.

By John Leighton.

The subject that I have the honour to bring to your notice this evening regards a matter of very high importance, namely, the more perfect representation of the people in the Imperial House of Legislature, and upon Boards and bodies returned more or less by constituencies.

Having been through two Parliamentary elections up to nomination as a candidate, and having assisted at the return, and at the declaration of the poll, in an important metropolitan borough, I am pretty well acquainted with the formula under the new Act, and able to form an estimate, both of its advantages and its defects; thus I will take my particular division as the model.

This evening we have mainly to do with the ballot, in fact with secret voting, and with the best methods of accomplishing the same with ease, economy, and surety. I will not touch upon "the register of voters," or upon its compilation, or upon its cost, though I have strong views about that, for I am assured by a member of her Majesty's Government that "registration" will have due consideration.

Thus I will begin with the assumption that we have got a cheap and perfect register of all persons entitled to vote, and who desire to exercise the privilege, be it Parliamentary, parochial, or other, a record that when once printed should be considered as final, as regards its year of publication, for I would make its issue annual, distinguishing by means of marks the quality of rights for which a vote is claimed.

For the nonce I will also presume that you are all acquainted with the formula of the ballot for members of Parliament, with its army of clerks, its improvised boxes, its secret compartments, its flimsy papers, its hindrance to business, and obstruction to education by the occupation of Board and other school-rooms, its impertinent and obtrusive canvass, which is a nullification of secrecy, and its system of carrying voters to the poll, with the farcical idea, that by the imposition of a favour, they create a reciprocal one in return, the touts outside to solicit your vote and interest, and the Jacks-in-office enthroned inside, who care little for either; the costly polling cards of varied hues, and the army of sandwich men, to be disbanded to-morrow.

I will also presume that you are conversant with the collection of the polling-boxes, and that you are familiar with the careless method of counting the votes, the smoothing out of the refractory crumpled ballot papers that will fall off the table, and the paid agents who dive after them, and who possibly, if so disposed, might manipulate, abstract, or add to the return, in the unseemingly scramble that not unfrequently takes place, when excite-

ment is at fever heat, with the dawn approaching, and supervision somewhat lax.

Of all this I would make a clean sweep, by substituting for it a State service most admirably organised, and vigilantly overseered, a system which, in place of four stations in the division of a borough, will give us forty, and tens of thousands all over the kingdom, for any period we please and at no cost whatever.

The fact is, I would employ the post, and make every letter-box serve as a ballot-box.

From the time of the issue of the Parliamentary writs to within three days of the poll, I would allow of "stumping" and "canvassing," but after the issue of the ballot papers there should be a close time, when no candidate or committee man, or election agent, should be allowed to let off political fireworks, or to hold communication with the registered elector for the purpose of influencing his vote, or in any way prejudicing a free choice, under a penalty of £100 or six months' imprisonment, or both.

The great thing wanted is to get at the voice of the electorate, and in this the present system lamentably fails, in the country perhaps more so than in the towns; and I have been informed by agricultural electors in council, that at certain times and seasons but few could or would afford to lose the time to vote as now, though all might under a postal system.

In Parliamentary elections we may put abstention at perhaps 50 per cent., and in parochial elections at 99. To get at this abstention ought to be our great solicitude, for I believe that it includes the most intelligent part of the community, including those who refuse to be trammeled and troubled with automatic machinery and unnecessary complications; in fact, to be treated as if knaves or fools, or incapable of exercising discretion, the imbecile voter being specially provided for; and it is but too true that his unit counts for quite as much as that of the philosopher's one. This the thinking man knows, and thus he refuses to appreciate the privilege of voting, or of wasting time upon the matter, a thing he ought not to be called upon to do, as is the case now.

Once I thought of making the ballot-box ambulatory, and as the elector refuses to go to the ballot-box, to take the ballot-box to the elector's house, and by assimilating the secret envelope system with that adopted for the election of the Board of Guardians of the poor, to utilise the police as collectors; but upon reflection I relinquished the idea, as it could hardly reach all absentees, and might be open to objections.

The post, we know, is the most important agent for the dissemination of intelligence, being employed for the conveyance of Parliamentary papers of the greatest importance, by the High Court of Chancery for writs, and by the Home-office for respite from death by execution, and by the seats of learning for the election of their representatives to Parliament. Now it is curious that intelligence should be returned openly and through the agency of the post, whilst the mass is denied the privilege.

I have been informed by the representative of a university, a man of very varied accomplishment, and moreover an authority in electoral matters, that he can see no objection to a universal return by post, which would give unity to the whole system, and make corporate colleges no exception to a rule. To effect a ballot by the post I would send to every voter upon the electoral list a red registered envelope, bearing the elector's number, as in Fig. 1; this would contain the enclosures No. 2 and 3, and might or might not be signed for at the houses of the recipients, at the discretion of the postal authorities, the only provision being the guarantee of accurate delivery, a matter of detail that might be safely left to the department.

Regarding the bulk occupied by these letters, I would note that much depends on the thickness of the papers employed, but if put into a column I think that 5,000 of the printed models I have prepared might be got into length of twenty feet; or that they might be put into a square box of less than two foot capacity either way, a chest that should be delivered to the postmaster of the district by the candidates personally, or in their name, by accredited agents, as sealed, certified, and correct.

These important letters should be included in the first delivery of a certain day, an accomplishment that could hardly be said to over-tax the powers of the post. Upon the opening of the official red envelope, Fig. 1 (p. 208), which the elector is particularly enjoined to preserve as an evidence of delivery and of verification should occasion arise—the voter will find the white envelope, Fig. 2 (p. 208), containing the secret vote, Fig. 3 (p. 208), with all directions for using the same, an act which only demands an intelligent choice, and the employment of a little moisture, and, moreover, the conveyance to the nearest post box in any part of the United Kingdom; and if posted before mid-

night on the day marked thereon, it will be included in the count, but if later will be lost.

I here append a copy of the secret vote, contained within the blue folio, No. 3, with its instructions to the voter.

The elector is requested, having fixed the enclosed adhesive wafer after the name of *the selected candidate only*, to seal up this paper and enclose it in the white envelope sent; which must be posted in any pillar-box or office before midnight on Monday, the 5th day of July, or the vote will be invalid.

The number upon the outside envelope is only for verification, and it will in *no way interfere with secresy*, as none of the envelopes will be opened until all are collected, and then only in the presence of the candidates or their accredited agents, who will place all the votes together previous to the tearing off of the edges, thus rendering identification with the voter impossible.

No candidate or election agent or committee man is allowed to hold communication with the registered elector, or in any way to prejudice his free vote after the delivery of the envelope, or before the close of the poll, under penalty of fine of one hundred pounds or six months' imprisonment.

No duplicate form will be given if this one is spoiled or otherwise defaced.

FOLD...FOLD

DAMP GUM HERE. — DAMP GUM HERE.

N. ST. PANCRAS ELECTION 1886

BROWNE, WILLIAM THE HON. WILLIAM BROWNE, M.A., 31, Belgrave-square, S.W.	○
JONES, THOMAS THOMAS JONES, Solicitor, 101, Gray's-inn-square, W.	○
ROBINSON, JOHN JOHN ROBINSON, Gentleman, "Ormonde," Primrose-hill, N.W.	○

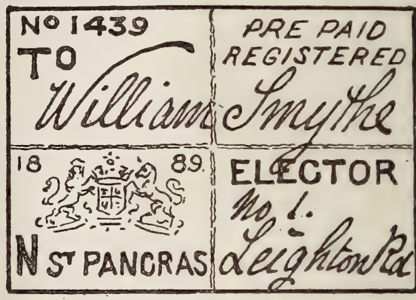
Remember—this gummed wafer is to be fixed after the name of the selected candidate ONLY, any other mark will invalidate the vote.

DAMP THESE EDGES AND SEAL UP FIRMLY ALL ROUND.

You will perceive that by the employment of an adhesive red disc I have relieved the voter of a pen, ink, or pencil to make a × (or what might in courtesy be called a ×) or to remind him of the sign manual of the illiterate. The electer now has only to find a little damp, and to convey the missive to the post.

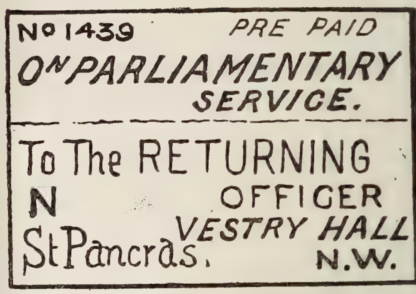
The Dilke-Gladstone + has many objections, as I will show, and might be used as a sign as powerful as the fiery cross of old. The crosses that pass current are of all forms, the Latin, the St. Andrew's, and the Maltese (†, ×, +). The Romanists might adopt the Latin, and the crofters and Scotch that of St. Andrew's, and hold communication with the candidate, a thing I defy them to do with the red wafer, which has no top or bottom, or side or back, and would have to be mutilated to become a sign.

FIG. 1.



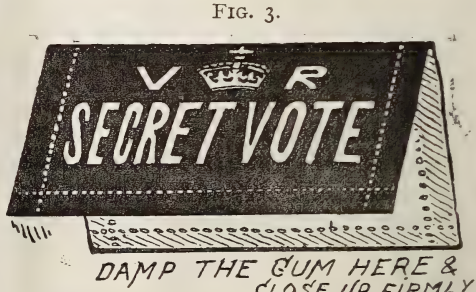
RED.—LETTER TO THE ELECTOR, THE ENVELOPE TO BE KEPT BY HIM.

FIG. 2.



WHITE.—ENVELOPE FOR SECRET VOTE TO BE POSTED WITH FIG. 3.

FIG. 3.



BLUE.—TO BE MARKED AND ENCLOSED IN FIG. 2.

Regarding the pressure upon the pillar-boxes, it probably would not be more than two or three hundreds of letters at each, and then not all at once, it being remembered that bulk number one (the red, white, and blue), for

delivery to the voter, would never go into a box at all, but direct to the sorting-house.

As the return (white and blue, Fig. 2 and 3) letters arrive they would be delivered to the borough box, kept at the Town or Vestry-hall, and there be dropped into a strong fire-proof safe, with divisions for the north, east, west, or south, as the case might be, until the seals upon the same were broken, and the safe opened by the Returning Officer in the presence of the candidates.

At the appointed time the scrutiny should commence, being conducted by the Returning Officer, assisted by a clerk, and in the presence of the candidates, whose first act would be the ranging of the white envelopes and enclosures in order, from No. 1 to No. 5,000, the whole of which would have to be "tick'd off," account being taken of those wanting.

This done, the opening of the envelopes would commence in due order disclosing the secret folios until a white and a blue pile be formed, the latter of which it is presumed would not be more than five feet in length, a block that would be put in a simple machine that at one stroke would sever the sealed edges, and thus liberate the secret votes, rendering the final count easy, a single card alone remaining to be dealt with.

The last inspection having been accomplished, and the candidates being of accord, the Returning Officer could declare the poll made, and post the result with all the numbers wanting, *nil*, or defective, upon every post-box in the district, that all who run may read it there.

To prevent appropriation or tampering, it should be made criminal for any voter, or other person, to mark, seal, or to post, in any box, without the special permission of the elector, any numbered envelope or enclosure on Parliamentary or other electoral service not his own, under a heavy penalty or imprisonment, the act being considered *forgery*. Absentees, hesitators, or objectors need not mark their papers, but it would be highly desirable that they should post their enclosures to render the return as complete as possible.*

Now it is quite possible, under the present ballot, for a person to vote at two stations, and to escape detection. By the postal numbered envelope system, a duplicate vote would be immediately detected, as a forged envelope and enclosure would be necessary that would not tally on collation. Now an absentee might never know that he had been personated; but by the postal system he would have the power of knowing that forgery had been committed, as he would hold as a voucher the official red registered envelope (Fig. 1) with its postal marks thereon; and such forgeries might be rendered more improbable by the candidates, who could stamp every envelope with their private brands.*

By such a system, abstentions would be remarkably few, as voters invalided, house-tied, on travel, or at office, could be got at—an advantage that would far outweigh any to be obtained by recording the votes at the present local stations, where ugly rushes take place early in the morning and late in the evening.

As regards county voting, the postal system would be invaluable. In my own case I have rarely recorded my county franchise, the distance from the polling place alone preventing me. The loss of voters from this cause is immense, and far outbalances any other objection to be raised against it.

With the adoption of the postal plan, I would begin at the root of all, with a perfectly new departmental organisation for registration, quite apart from personal or parish influence, which is costly. I would by no means wait to make essay at a general election, but begin quietly with a county and a borough, noting effects, and gradually extending operations, gaining experience until all be perfected from the base to the apex.

BALLOT VOTING APPARATUS.

By James Withers.

The subject which I have the honour to bring before you this evening is one of more than ordinary interest to those who place themselves under the trying ordeal of a contested Parliamentary election! After the mind and body of an energetic candidate has been excessively worn by a spirited "canvass" of several thousand electors, as the closing hour of the poll is reached, the greatest tension of anxiety is attained, not only by the candidates themselves, but by their political friends—irrespective of "party bias."

* It might be politic to inflict a fine of 5s. upon all who approved of their name being upon the register, and who failed to post the white return with its enclosure (marked or unmarked); the request is so small that it ought to be complied with. This would give an approach to obligatory voting that has often been mooted.

* As to the danger of forged papers being fabricated—the making would be so difficult with its checks and counter-checks, as to approach to an impossibility, and so costly as to render it an improbability.

It is at such a moment of strained anxiety that the invention, which I have the honour to exhibit (after many years of thought and abour) comes in, to effectually remove the objections of the present admittedly unsatisfactory system.

The apparatus before us (simple and self-acting), with unerring exactness, gives the result of a contested Parliamentary (or other) election as soon as the poll is closed, no matter how large the county may be.

At eight o'clock in the evening the die has been cast, the choice of the electors has been fixed. As the result cannot then be altered, is it not better and more kind to those concerned that the decision, so very important to all classes, should be made known at once, instead of delaying the issue through the weary hours of the night, or until the next day? Or as in the case of "Saturday elections," often till Monday noon, thereby extending the mental strain over 30 or 40 hours. The apparatus before us knows nothing of "party bias," it automatically records each vote given for each candidate, whichever may be selected by the voter. In the supposed case before us, we have three candidates putting up for the one seat.

Every vote given must pass to the counting instrument provided for each candidate. It supplies a want which all political parties have admitted has long existed—an improvement which voting by paper rendered impossible.

In using voting-papers, as at present, they have to be examined, to ascertain whether the voter's cross has been placed in the proper position. Often by nervous persons (under the excitement), as well as the illiterate and aged, the X is improperly placed *on the line* between the two candidates. A party dispute arises between the examiners, which is ended by "Well, then, throw the paper aside," and the vote is lost. After a series of such disputes during the weary hours of the night the counting and recounting of the voting-papers—deferred by the sharp quarrels—begins, and much time is absorbed until the approved total is arrived at.

Amongst the many features of the "voting apparatus," which found special approval in the House of Commons (in which I had the honour of exhibiting it to the members daily for ten weeks in two Sessions), the absolute prevention of "spoiled voting-papers" seemed a special favourite. With this apparatus you cannot have one vote lost. The simplets person who can drop a penny into a money-box can vote as correctly as the Lord Chancellor.

Instead of a "voting-paper" I use a metal disc. These discs are impressed with a consecutive number.

If a presiding officer requires 980 for the electors on his portion of the register, he will be supplied with 1,000 discs, spiked on files of 100 each. The presiding officer, accompanied by political agents on each side of him, will be seated at one end of the room, and will have the back of the apparatus always in his view, that being placed at the opposite end of the room. When a voter presents himself the presiding officer will ascertain his number on the register (say 732), and place against that number the number of the disc (say 1), which he hands to the voter, and instructs him to proceed to what we will call the "secret voting chamber." The voter passes the "entrance door" to the secret chamber, and there faces three small "voting doors," bearing the candidates' names, say, Adams, Brown, and Cozens, in the case before us.

If the voter intends to vote for Brown he will open the small Brown "voting door." He will then drop the disc into the brass slot before his eyes, and having voted, leave by the "exit door," the only way he can get out, and the next voter follows in quick succession. Ten persons can vote in one minute, 600 in one hour, and 1,000 voters, supposed to vote at this district, in less than two hours. It is therefore much quicker than the present system.

If the voter cannot read we assist him. His friends at their committee rooms would supply him with a coloured card agreeing with the colour previously chosen by his candidate. In the present case Adams has adopted red for his assisting colour, Brown has stuck to brown, and Cozens has chosen blue. The illiterate voter is instructed to take, say, the red card, with the name of Adams printed on it. The voter will match the colour of the card with the red "voting door." We thus assist the illiterate voter if we cannot make him perfect. He opens the red "voting door," places his disc or vote in the slot for his political friend the candidate, and passes out by the "exit door," which closes by a spring against his re-admission.

The presiding officer placing the number of the voter's disc on the printed register serves several purposes; it shows that the voter has had his vote. Should he later on attempt a fraud by trying to get another vote the record would defeat him. "He will have no more."

It also enables a scrutiny to be had, if demanded under the authority of Parliament. The number of the disc will identify the voter.

It is obvious that every possible safeguard against the many frauds committed at elections must be provided for by the inventor of an automatic method of recording votes. I will now explain the various means employed to prevent fraud.

As only one member is to be returned for the one seat vacant, the voter who fraudulently attempts to give two votes for a candidate will find it absolutely impossible to give more than one. When the voter has dropped his disc into the brass slot, it remains there in the slot until he has left the "secret chamber," and cannot return again.

The slot being full he cannot possibly get a second disc into it. A strong flat iron-bolt beneath the slot prevents the disc from falling to be recorded. The voter who has voted, simply *deposits* his disc (and he cannot get it out again), and then quickly leaves the secret chamber. After that voter has left, the next voter (whenever he may come), upon his opening the entrance door unconsciously lets the former disc drop on to the counting instrument, and instantly the former voter's disc is recorded in favour of the candidate chosen by the voter. Thus we have two independent persons unconsciously engaged in completing the one act of voting.

By the same automatic action, at the same moment, the succeeding voter sets free the two bolted voting doors, which the former voter had unconsciously bolted against himself; which were bolted to prevent him from giving a fictitious vote to a second candidate, it may be out of some personal respect. Possibly he may try a five shilling piece (as resembling the disc), but I have provided that a crown piece will not enter the slot, and that no English coin shall be able to record a vote. A voter may bring a dozen discs (they are easily made), but he can only use one at any given election. By the same automatic action, at the same moment, the succeeding voter closes the small voting door, left purposely open by the former voter, and which shuts by a spring. This is accomplished before the succeeding voter reaches the front of the three small voting doors by the action of the entrance door. He will then find that all three of the voting doors are closed, but each entirely free to open to his inclination.

The presiding officer, accompanied by the political agents, will, at 8 p.m., enter the secret chamber, and therein delare the poll closed. His going in causes the last disc deposited to fall and be recorded for whichever candidate it was given, without his knowing for whom it was cast.

When the voter is in the act of turning the brass handle of the small voting door (in the ordinary way of opening a room door), on his turning the handle a quarter of an inch, he unconsciously locks the other two voting doors. He turns the handle a quarter of an inch more, and the voting door then opens; the slot to receive his disc is before his eyes. If he opens the middle voting door, he thereupon automatically bolts the door on each side of it. If he opens Cozens's voting door, at the right hand, he will bolt the two doors to the left of Cozens's door. If he opens Adam's voting door he will bolt Brown's and Cozens's voting doors, so that it is impossible to vote for a second candidate when only one member is to be returned.

The provisions made against giving a second vote for the same candidate, or a second vote for one of the two other candidates, found strong approval in the House of Commons during the ten weeks I exhibited the apparatus there, as did also the extremely simple method I have adopted for securing absolute secresy in voting, if preferred to scrutinies, which are often expensive, and seldom satisfactory; simply remove the two partitions in the "disc-receiver," and let the discs fall in common and intermixed, and it then becomes absolutely impossible to ascertain for whom any voter has given his vote. Yet by the simple process of dividing the "receiving drawer," a scrutiny can be had (if demanded) whereby the secret of every voter may be revealed, sometimes a serious matter to professional men, especially clergymen, doctors, and others.

The two books of autographs before us show the extensive favour the voting apparatus received in the house of Commons. I have here the signatures of 493 members of Parliament, and thirteen peers.

Many members considered that the question of spoiled votes had reached alarming proportions, whilst not one could occur with the apparatus before us. In many cases of contested elections dealing with thousands of electors, the majority can be counted on the fingers of one hand. In Ayrshire S., with over 15,000 electors, majority only 5; Finsbury Central, with 7,462 electors, majority only 5; Yorkshire E., 9,110 electors, majority only 6; Liverpool

Exchange, 8,171 electors, majority only 7; Cardiganshire, 18,123 electors, majority only 9.

One member told me he had 176 spoiled voting papers. The county of the Isle of Wight, which is honoured by having the Attorney-General for its member (our worthy Chairman) had no less than 45 spoiled voting papers. His majority was very large, and spoiled papers did not trouble him. But the same island not long since decided its election by a majority of 9, being one-fifth of the spoiled papers of the last election. The spoiled voting papers throughout the kingdom are legion.

The counting instruments will be set at zero before opening the poll, and will be placed by the presiding officer in their proper situatoins. At the close of the poll, in the presence of the same witnesses, he will break the seals, and wire to the sheriff (in the centre of the county) the numbers recorded for each candidate. In a few minutes the returns will be added, and the result (approximate) will be known throughout the nation.

Before the sheriff declares the poll (next morning) he will verify the telegrams by seeing the "counting instruments," which will be speedily placed in his hands by each presiding officer (under seal). Each counting instrnment is fixed in a case with a sliding cover. At the close of the poll, when the cover is sealed, the "counting instrument" becomes "dead," and will not act.

Provision is also made for the return of two members, in the few cases remaining; and also for plumpers, or against plumpers, as may be decided by Parliament.

APPARATUS FOR VOTING BY BALLOT.

By John Imray.

The name of the late John Coope Haddan must be familiar to many members of the Society of Arts, in connection with improvements in ordnance and projectiles, to which Mr. Haddan for many years devoted himself.

In 1870, Mr. Haddan directed his attention to mechanism for taking votes by ballot and recording their numbers, and he took a patent, No. 257 of 1870, for apparatus which he contrived for this purpose. In working out this invention Mr. Haddan came into communication with me, and I suggested certain improvements, and the result was a joint patent, No. 2721 of 1870, embodying these improvements.

The mechanism in its improved form involved interlocking gear resembling that which had been applied to the levers employed for working the points and signals of railways. The patentees therefore put their specification before Messrs. Saxby and Farmer, the eminent contrivers and makers of point and signal apparatus, who made the model now exhibited, and who have kindly cleaned and repaired it for the purpose of its exhibition.

The model, as it is made and adjusted, is suited for giving two votes in a case where there are three candidates, and it may be interesting to notice that two of the names marked on the model are those of the two great political antagonists, Gladstone and Disraeli, who were before the public when the model was made. Although the model is adjusted for the election of any two out of three candidates, the mechanism is of such a kind that it could be extended to embrace a greater number of candidates, and to permit the voter to give only one vote or more than two votes.

When Mr. Haddan first thought of this invention, his idea was to substitute a mere mechanical action, like that of moving a pump handle, for the very humble literary effort involved in making a cross or other mark on a card. That even the marking of a ballot paper is beyond the reach of some voters who have been thought worthy of the franchise, may be illustrated by an occurrence witnessed by me at an election for the Hornsey division of Middlesex. There were two candidates, Lord Kensington and Sir James McGarel Hogg, now Lord Magheramorne. A voter, on receiving his card and being told to mark a cross opposite that of the two names which he chose, could not be made to understand what was expected of him, but continued to stand by the clerks' table ejaculating "I'm for Lord 'Ogg, I am—I ain't a-going to put my mark to this thing!"

Among the many mechanical actions applicable, such as pulling a handle, pressing a key or knob, it was thought best to select one such as many of the voters might be accustomed to, the movement of a lever like a pump handle. This movement has to produce various effects in the way of locking and unlocking others of the levers in the following manner:—

1. When one lever is being pulled down all the others are locked, so that only one can be pulled down at a time.

2. When the one lever is pulled quite down

it is locked in that position, and consequently the voter cannot give two votes for one candidate.

3. Also when a lever is pulled down, the counter appropriated to that lever is moved one tooth, recording the vote and adding it to the number already given for that particular candidate.

4. And, finally, when a lever is pulled down, it unlocks both of the others, so that the voter can mark either of them for giving his second vote.

5. But when this second lever is pulled down it does not unlock the third, and consequently the voter cannot give more than two votes.

Assuming that the voter has given his two votes, he quits the voting chamber, leaving two of the levers depressed. These remain depressed until the attendant withdraws the door bolt to admit a succeeding voter; this withdrawal effects

6. The unlocking of the two depressed levers, which, in obedience to a weight or spring, return to their normal position ready to be worked by the fresh voter. The voting handles are within a closed chamber, so that no one but the voter then occupying it can know how the votes are given. The counters also are closed, so that no one can see how the numbers stand, or how they are changed, until the proper official unlocks them and sees recorded on them the number of votes given for each candidate. Although these counters are arranged in the model to be worked directly by the voting mechanism, they might obviously be at a distance worked either by mechanical or electrical connections, as suggested in the patent specifications.

The interlocking mechanism, arranged to perform the functions above mentioned, is comparatively simple in character, consisting mostly of a repetition of parts for each lever. The interlocking movement is communicated along the row of levers by a set of sliding bars, provided at proper places with stops, which either come in the way of and obstruct some of the levers, or are moved out of their way, leaving them free according to the primary adjustment of the apparatus or its temporary condition.

It is only right to mention, in conclusion, that this balloting apparatus has never been brought into practical use, and that, as the patents expired several years ago, the invention, such as it is, is open to the public, if the public should think proper to adopt it as a whole, or utilise the principles on which it acts, or the mechanism in which they are embodied.

DISCUSSION.

The Rev. J. F. BATEMAN, being called upon to explain a system of taking the ballot which he had devised, said—I have here two boxes exactly the same, one as it appears shut, the other open. I am supposing that a literate voter comes in front of this box, having been duly verified by the polling clerk. Another polling clerk at the box slips a card into this little frame, with the names of the candidates upon it, the wires exactly coinciding with the lines which divide the names on the card. The voter comes in front here, his hand and wrist being entirely concealed from the polling clerk. He makes his mark, the clerk pulls this handle, and the card drops into the box. The next man I will suppose to be an illiterate man, who can barely read, if at all. The card is slipped in as before; his friends have told him that his candidate is No. 1, 2, or 3, and he puts his mark to the number accordingly. Even supposing the voter to be blind, if he knows the order number of his candidate, he feels with his fingers the dividing wire, and makes his mark in the same way. I have sketched the course of a voter. He would come first to the table, which I call the register table, where there is a clerk with the register, who gives him a pass ticket simply stamped with a number, say number nine, he being the ninth who has come to vote. He then goes through a little barrier, which may be a rope stretched across the room, and comes round to where the ballot-box s placed. One of the poll clerks takes his pass ticket and drops it into a box, and puts a tick opposite inumber nine, to indicate number nine is entitled to vote. Then he came and made his mark, as I showed you just now, and passes on. In this plan the elector cannot take the card into his hand; he cannot practice what is called the "Tasmanian dodge," he cannot hold it up to show how he has voted, which is an offence under the Act. There are four or five offences under the Act of a similar kind, which in this case, are impossible, and there is the facillity to the illiterate and blind voter. I have tried with both kinds of men, and venture to think the plan is satisfactory.

Mr. A. E. MILLER, Q.C., said he might mention, as a matter of history, that practically the same suggestion as had now been made in Mr. Leighton's paper he had heard some thirty-one years ago, on one of the first occasions he was ever present in the galleries of the House of Commons, in a speech made by Mr. Bright, when the ballot was in the air, but was supposed never to be likely to be adopted. He at that time sketched what he

thought to be a perfect way of taking votes by ballot, which, in all material details, was identical with the scheme now brought forward. He had not considered the subject sufficiently to discuss the suggestions made to-night, beyond saying that he was satisfied that anything which would enable votes to be taken without the necessity of personal attendance at a given station would be a great benefit to the electors at large, and would help very much to get the sense of the people, which at present could not be obtained. He took a great interest in the election of 1885, in the contest in the Harrow division of Middlesex, and there he found the real difficulty was to get men to go to the poll at all. He called at several houses when the men came in—between six and seven, having been out all day at their work—and, of course, they wanted their tea, and after that they made all sorts of excuses—that they had taken their shoes off, and so on, and they could not be got to the poll, even when they were offered to be taken in a van. Instead of having two-thirds of the voters giving votes at an election, if the poll were brought to them, nearly all would probably vote. Whether Mr. Leighton's was the best way of accomplishing that he had not considered, but the same system substantially had been elaborated many years ago, by a man who took great interest in furthering the success of secret voting.

Mr. JOHN BRAYE was not prepared to give any opinion on the machinery brought forward, beyond saying that he saw something almost exactly similar 20 years ago, made by Mr. Chamberlain. Mr. Leighton's was a charming theory, but it was only fit for one of those constituencies which were pictured by Dr. Richardson and Mr. Frederic Harrison, or it might do for an academical assembly; for the rough and tumble business of an ordinary election, Parliamentary, municipal, or Board of Guardians, it was utterly unsuited. In his opinion, voting ought not to be made more simple and easy, but, if anything, more difficult, and the only good suggestion he found in the paper was that for imposing a fine for not voting. If people were not capable of exercising the franchise, why should you trouble about them? He then proceeded to give his experience of an election in the parish of Kensington for the Board of Guardians, and described the manner in which the plans of a ratepayers' association which for some time had kept matters entirely in their own hands, had been checkmated by organised efforts. He also produced specimens of voting-papers which had been used at that and similar elections, of various colours, and pointed out a defect in the Act which he said he had brought under the attention of the Government, inasmuch as it did not make the use of the voting-paper supplied by the returning officer compulsory. It had come to his knowledge that voters occasionally put in more than one voting-paper. Voting ought to be made more difficult, not more simple, than it was already.

Mr. R. SIDNEY ELLIS said he had had considerable experience of the present mode of balloting, having served at every contested election in one of the largest London boroughs, and in every capacity from that of a polling clerk to that of deputy returning officer. Mr. Leighton's suggestion for making use of the Post-office would no doubt be a very efficient way of taking a poll, and, combined with a fine, would be a great spur to make electors vote, but he saw great difficulty in ensuring secrecy. You might talk about penalties and imprisonment for certain offences, but unless you could prove the offences such regulations were useless. The great difficulty would be to prevent electors having their papers marked and posted by the agents, official or otherwise—most probably otherwise—of the candidates. He did not see how undue influence could be prevented, and this difficulty would be fatal to any scheme of voting by means of the post. Mr. Withers's machine seemed to him more hopeful than anything he had seen, and if one or two little deficiences could be got over, it would be almost perfect. The first was the cost and the complication of the machine itself. It appeared to work very nicely now, but it would be impossible to tell before an election how many candidates there would be, and the time between the nomination and the polling, especially in boroughs, was very short. He should be glad to know whether the machine could be constructed or arranged for any number of candidates which might be required in the limited time there would be at command. Another slight difficulty was with regard to the counters falling into the box, and the case of a scrutiny. Under the present system the poll clerk who gave out the ticket marked the counterfoil with the number corresponding on the register to the voter's name; that was not marked on the ballot paper, but another number on the counterfoil corresponded with the number on the back of the ballot paper. It was therefore impossible to tell how any one had voted without bringing the ballot paper and the counterfoil together again, and the presiding officer was obliged to seal up the counterfoils, which could only be compared with the ballot papers if a scrutiny were ordered. With this machine the number of the voter was on the disc itself, and anyone by getting the disc out of the drawer could see how the elector had voted. No doubt, however, that difficulty could be got over. With respect to the last proposed machine, there seemed to be no check at all; any number of electors, or anyone not an elector, might go in and work the pump handle.

Mr. W. H. ROWE thought all would agree that there were four essentials to the proper working of any ballot system—secrecy, simplicity, certainty, and means, if necessary, for judicial inquiry afterwards. Tried by these tests, the first objection to Mr. Leighton's plan was that there was a good deal of human nature about postmen, they were by no means infallible, their action would often be erratic, many

papers would never get delivered, and there would be no certainty in the result. Again, there would be a certain possibility of forgery; there would be great difficulty with regard to voters who had removed, but who were still on the register; there would be no means of ascertaining that the paper reached the person entitled to receive it, or that the person entitled to fill it up had done so; and it would be impossible to know how many voters had actually polled. It would not prevent canvassing. Mr. Leighton's proposal to inflict a penalty on any person who canvassed in the interval between the issuing and the return of the papers, had been thrashed out in the House of Commons, and found impracticable, and, lastly, there was no provision for a scrutiny. With regard to the proposal of Mr. Withers, there was no doubt much greater simplicity and certainty, but he thought there was considerable opening for fraud. Could not the first voter who entered take away his disc without voting at all? and, if so, in a couple of hours would it not be possible to forge a number of the discs, which might be used by the voters? Moreover, it could be made an effectual machine for bribery. Mr. Withers calculated that 4,000 voters could be recorded in eight hours, but that was presuming that the voters presented themselves with perfect regularity, and that there was no crushing or confusion. The fact was, however, that voters came in batches at irregular intervals, and at the close of the poll there was often considerable confusion, and unless the system for unlocking the doors was extremely strong, it would not resist the rough usage which would arise, and the result of the election would be upset at the end of the poll. He did not think much importance ought to be paid to spoiled votes; if people were so ignorant as to spoil their votes, he did not think they were worth consideration. The proposition as to using the telegraph to record the result of the poll, as shown by the counting machine, was also open to objection. At present any one was prevented from knowing how the votes preponderated in any particular district; but under this system it would be known at once, and therefore he thought that the plan of obtaining the result by telegraph would be absolutely inadmissible. He had not quite followed the explanation of the third system, but as somebody had meddled with the machine and put it out of order, it was possible that the same thing might occur in practice, and that would condemn it in its present form. Mr. Bateman's plan seemed open to one objection, and that was the impossibility of preparing the boxes, between the interval of nomination and the poll, for the requisite number of candidates. He did not think, on the whole, there was much fault to find with the present system. It had been in operation fifteen years, and its imperfections had not caused many difficulties.

Mr. OLIVER J. WILLIAMS thought it would be quite as well if illiterate voters did not vote; the great object was to get qualified and good members of Parliament through the votes of qualified and good electors. Great difficulties occurred to him with regard to posting, some of which had been already referred to, especially the danger that the papers might be tampered with, and there being no evidence available to prove it. An automatic machine seemed a very desirable thing for so important an object, and he would suggest that the Society, or perhaps the Government, should issue papers naming the conditions, and offering a prize for the best machine which would fulfil them. Possibly electricity might be brought into use in the same way as it was in the tape machine used on the Stock Exchange; but one difficulty he saw in connection with any automatic machine was that so many Englishmen, he was sorry to say, at election times, were not very clear-headed at the end of a polling-day, and were rather too vigorous, and unless very strongly constructed, or specially guarded, the machinery might be put out of order.

The Rev. Mr. BATEMAN wished to point out that a new-ballot box would not be required at each election, only a new frame, and very often there were the same number of candidates, or not more than a certain number, in which case the existing frames would be available.

Mr. TRACY thought any one who had observed what took place at election times would feel that machinery of this complicated description would not do. The present mode of voting was as good as could reasonably be expected; and if instead of so much numbering, care were simply taken that every voter had a vote, and that he dropped his ballot into the box in presence of an official, and, to prevent fraud, that the counting was done immediately afterwards, there would not be much room for improvement. If time were allowed, chicanery was sure to take place.

Mr. CARPMAEL said there was one chance of error which seemed to have been overlooked. One of Mr. Leighton's objects was to get rid of the number of hands now present, and let the result be recorded by the returning officer and his assistants. He had put up a large diagram showing the supposed result of an election, in which Mr. Windbag had 2,501 votes and Mr. Probity 1,984, and under it stated that the former had a majority of 1,517. If such an error as that were possible, a slightly greater one might result in the wrong man being returned.

Mr. LEIGHTON said he had only three words to say in reply, viz., that the Post-office system was most economical, that it would get at all the absentees, and that probably it was the safest.

Mr. WITHERS said in his machine provision could be made for more than three candidates, but he rarely

found there were more than three. It could be arranged for any registered number. With regard to the danger of duplicate votes, it was absolutely impossible. The elector once having placed the disc in the slot could not remove it, nor could he put in a second one. He was glad the question of cost had been raised; it was one frequently put to him by members of Parliament. He had before him the amount charged to the two candidates for the Enfield division of Middlesex, showing that they had each to pay £473 for the returning officer's charges, and out of that sum, by the use of this apparatus, they could have saved £275 4s. Complaints were made of these charges every time, but they remained just the same. He had taken 10,000 votes in the House of Commons with six discs, and the apparatus itself would last a considerable time, so that the expense of renewal must be small. One of the members said to him that if he had 27 stations, even at £20 each, that would come to a large sum. His suggestion was that the county or borough should possess these machines; they would do for all time, and if it was thought fit to charge the candidate, say 10 per cent., for the use of them, they would soon pay for themselves; that would only be about £2 each machine at an election. Then the objection was raised that it would be so cheap that everybody would be putting up. Only one gentleman had referred to the next important question, viz., that the result might be known as soon as the election was over; and he raised the objection that it would be known in each neighbourhood who had voted. Did they not know now? He knew it so accurately in the Isle of Wight that on one occasion he foretold the exact number which a candidate would poll, four days before the election. By this method the result would be known a few minutes after the election was over. It was said also that a voter might take away his disc and get others made, but if he did they would be of no use; every voter had to go before the presiding officer to get his number marked and receive his disc, and if he brought a dozen more with him he could not record more than one vote.

The CHAIRMAN then proposed a vote of thanks to the three gentlemen who had read papers, and to Mr. Bateman. They were much indebted to Mr. Leighton for the extreme care with which he had worked out his scheme, and the perfect manner in which he had brought forward his exhibits, and it was with some regret he felt bound to say that he was afraid there were some insuperable objections to his system. He quite agreed that if it could be effectively put in force, it would secure a thorough representation, but neither Mr. Leighton nor anyone else had dealt with what seemed to him to be really the greatest difficulty: that there was, practically, no safeguard against personation. Mr. Leighton said the Post-office could give some security, by either registering the letters or delivering them to particular persons, but even a registered letter would practically be no safeguard in many cases. Take a mining village, where many men might be down the pit when the letters arrived; the letters would be left, and the postman would call again for the slip of paper which would be signed by the wife, or by anyone who could write, and in nine cases out of ten the voter would never see it at all. One gentleman had pointed out an objection which went to the root of the matter, and seemed to be fatal; what was there to prevent an agent—an unscrupulous agent—finding out when the letters were going to be delivered, getting hold of any number of them from the postman, perhaps two or three hundred for £50—worse things had been done—affixing the wafers, and sending them back? He was sorry to think that there was such an apparently fatal objection to a system which had been so thoroughly worked out. If they were prepared to face the possibility of personation, and to take the average result, all being willing that such electors as received their papers and returned them, should be taken to represent the electorate, the other objections would be small, but as long as they were to rely on postal delivery, and on the receipt by working people, many of whom would be away at the time the papers were delivered, he feared the system would not work. There were some other small objections, and he thought Mr. Leighton had rather weakened his case by substituting the wafer for the mark. A wafer did not always stick, and it might be removed from where it was placed to another part of the paper, so that he thought the original plan of marking the paper indelibly was preferable. With regard to a fine for not voting, as had been pointed out already, such fines could not be enforced. Some of the voters might be away, others would say they had not received their papers, and so on. You must trust to the growing intelligence of the people, and though he agreed there had been a large number of absentees, still at the late election at Winchester 95 per cent. of the electors voted, and as election matters were more understood he thought there would be fewer absentees. He had seen Mr. Withers's system at work in the House of Commons, and thought when Mr. Rowe examined it more carefully he would find that some of his criticisms were not well founded. It was certainly impossible that there should be any forgery or duplicate voting. The voter must enter the room, get his disc or voting paper from the presiding officer, and he could not pass him again without giving his name. If his name were only ticked the first time it would prevent his getting a second vote. There was the additional safeguard that no one voter could put more than one disc in, and that the vote could not be recorded until the voter had gone out of the room, and he could never come back into it again during the same election. Mr. Withers also, he thought, with his extreme ingenuity, had somewhat weakened his own case. It was not necessary to resort to the telegraph and the number

of votes given in each district. That was not the essence of the system; it was only a convenience which might be adopted or not. There was no reason why the district numbers should not be kept perfectly secret if preferred, the tell-tale need not be used at all; the discs might be collected in sealed boxes, all put into one bag, and counted at the central office. But there was this double check; first, there were the discs in the boxes or compartments (he would suggest in separate boxes), and, secondly, the counter, so that if the counter went wrong it would be checked by the discs. The object of the counter was simply to facilitate counting, and he really thought the objection to knowing the number of voters in any particular district was practically becoming obsolete. He did not see why, so long as the ballot was secret, there should be any objection to that particular fact being known. But, be that as it might, that was only an incident of Mr. Withers's machine. He was strongly in favour of this mechanical voting—not because he wanted to assist the illiterate voter, for he sympathised with the idea which had been expressed, that if people did not understand how to exercise the franchise, they ought not to do so—but once this apparatus were provided, there was no reason why the expense of elections should not be enormously diminished, and though he did not want to make elections too cheap, he did not want to waste money over them. A great deal of the present expense was in printing ballot papers, which were useless afterwards, and if it could all be done for £30 or £40 a machine, the mere substitution of the names being all that was required at each election, it would be a very great improvement. His suggestion would be that if it were taken into consideration, some properly constituted authority, such as the Board of Trade, or the Local Government Board, should pass the machines, subjecting them to any test which might be deemed sufficient to ensure their standing ordinary wear and tear and any rough usage which they might be expected to meet with under the circumstances which had been alluded to on a polling day. Secrecy could undoubtedly be secured. The number on the disc need not be put against the voter's name; there need be no more connection between the register and the disc than that which existed with regard to the voting papers, and that was, in fact, all the connection which Mr. Withers suggested, but as now there could be arrangements so as to prevent any possibility of identifying a particular vote except in case of a scrutiny. The clever arrangement of Mr. Bateman's had many elements of utility. In all probability a man marking a paper on one side of a small screen, and a clerk sitting on the other, might be open to objection, but assuming the box to be safeguarded by a larger screen, the idea of marking the card and then dropping it into the box was for all instructed voters a very excellent one; he was not so sure that it would be well adapted for the illiterate. Everything which Mr. Imray produced was sure to be first-rate from a mechanical point of view, and he did not think that Mr. Rowe's criticism should be applied to it, because he did not suppose the actual working machine would break down. He would suggest, however, that the pump-handle motion was rather suggestive of a low individual capacity, and the practical objection to it was that he thought it was of importance that the voter should feel that he had actually done something himself, and he doubted whether moving the handle of a machine would convey the same impression to him. One might think he had not moved it far enough, and another that it was not in the right direction, and if one happened to come in who was a little excited, and rather strong, he should tremble for the pump-handle more than for Mr. Withers's doors. They were indebted to Mr. Imray for reminding them of a name well-known in the mechanical world, and also that the idea of mechanical voting was by no means new.

The vote of thanks was carried unanimously, and the meeting adjourned.

Correspondence.

A NEW DEPARTURE IN BRAZING AND WELDING.

The cheapening of oxygen by Brin's process of manufacture has put into the hands of metal workers a new power. I have recently made a few experiments with the compressed oxygen and coal gas, and found that with a ½-inch gas supply a joint could be brazed in a 2-inch wrought iron pipe in about one minute, the heat being very short, the redness not extending over one inch on each side of the joint.

The appearance of the surface after brazing led me to experiment further with welding, a process which is not possible with ordinary coal gas and air, owing to the formation of magnetic oxide on the surfaces. Contrary to my expectation, a good weld was obtained on an iron wire one-eighth of an inch diameter with a very small blow-pipe, having an air jet about $\frac{1}{32}$-inch diameter. This matter requires to be taken up and tried on a large scale, for such work as welding boiler plates, which, it appears to me, can be done perfectly with far less trouble than would be required to braze an ordinary joint. The great advantage of this would be that the boilers would require no handling, but could be welded with an ordinary large blow-pipe in position, and with about one-tenth the labour at present necessary.

The cost of the oxygen is trifling, and it is evident, from the results obtained in brazing, that the consumption of gas would be considerably less than one-fourth that necessary with an air blast, irrespective of the fact that welding is possible with an oxygen blast, whereas it is not possible if air is used.

The surface of iron, heated to welding heat, by this means comes out singularly clean, and free from scale, and a small bottle of compressed oxygen, with a blow-pipe, and a moderate gas supply, would make the repairs of machinery, boilers, brewing coppers, and other unwieldy apparatus, a very simple matter. The trouble and difficulty of making good boiler-crowns, which so frequently "come down," would be very small indeed, when the workman has an unlimited source of heat at command, under perfect and instant control.

THOS. FLETCHER.

Warrington, January 17, 1888.

General Notes.

EXHIBITION OF WORKS IN WOOD.—The Masters, Wardens, and Courts of Assistants of the Worshipful Company of Carpenters, and of the Worshipful Company of Joiners, of the City of London, propose to hold an exhibition of models, drawings, and specimens of works within the respective trades designated by their titles, executed or to be executed in wood, to be held at Carpenters'-hall, London-wall, in the City of London, in May and June, 1888, and prizes are offered in each of the following classes:—First Division—Constructive carpentry, in which skill in obtaining the greatest amount of strength at the smallest expense of material and labour shall be the object. This division includes five classes. Second Division—Constructive and ornamental carpentry, in which skill in obtaining architectural or picturesque effect, combined with strength and economy in material and labour, shall be the object aimed at. In this Second Division (including four classes), the judges will take into consideration, and balance against each other the two essential elements of strength and architectural effect, to be obtained at a given cost of material and labour. Third Division—Joinery in the under-mentioned divisions and classes, all to be hand work, and not machine work, and in wood (six classes). Fourth Division—Carving in wood, all to be hand work (two classes). Fifth Division—Models or drawings of existing examples, ancient or modern, coming under any of the foregoing classes (three classes). Application for further particulars may be made to Mr. S. W. Preston, Carpenters'-hall, London-wall, London, E.C.

FIRES IN THEATRES.—In a paper published in 1887, Professor Meidinger, of Carlsruhe, submitted some suggestions for the prevention of loss of life from fires in theatres, which if acted upon would lead to the adoption of principles entirely different from those which generally rule in the construction of theatres. Professor Meidinger remarks that most deaths are caused by suffocation, not by burning, and that if the smoke and flame, with the products of combustion, could be kept out of the auditorium, any fire on the stage, however extensive, would be without risk to the spectators. To ensure this object, he proposes that large openings should be provided in the roof of the stage, fitted with trap-doors. These trap-doors would be opened on the breaking out of a fire, they would afford an outlet for the heated and expanded air, and a draught through them would be set up. The effect of this would be to cause a draught to set from the auditorium towards the stage, and through the outlets. To ensure their being opened on the outbreak of a fire, they might be constructed so as to open inwards by their own weight, and to be held up by means of rope, which would be burnt by the fire. In addition to these, means of opening them simultaneously by hand would be provided. Professor Meidinger also lays stress upon the value of such arrangements for ventilating purposes, and instances the arrangement at the Canterbury Hall, a large portion of the roof of which is removable, as showing the perfection of ventilation attained by such means.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 25.—"Theatres and Fireproof Construction." By WALTER EMDEN. LORD SUDELEY, Member of Council, will preside.

FEBRUARY 1.—"The Sweating System, or the Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

FEBRUARY 8.—"The Continuation of Elementary Education." By W. LANT CARPENTER, B.A., B.Sc. THE RIGHT HON. SIR LYON PLAYFAIR, K.C.B., M.P., F.R.S., will preside.

FEBRUARY 15.—"Type-writers and Type-writing." By JOHN HARRISON.

FEBRUARY 22.—"The Technical Education Bill." By SWIRE SMITH. PROF. SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

Dates to be hereafter announced:—

"Technical Instruction in Agriculture." By PROF. JOHN WRIGHTSON.

"Machine Tools for Boot and Shoe Manufacture." By JOHN W. URQUHART.

"Framework Knitting." By W. T. ROWLETT.

"Locks and Safes." By SAMUEL CHATWOOD.

"Telescopes for Stellar Photography." By SIR HOWARD GRUBB, F.R.S.

"The Measurement of Electrical Currents." By PROF. GEORGE FORBES, F.R.S.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

FEBRUARY 7.—"British Columbia." By HENRY COPPINGER BEETON, Agent-General for British Columbia.

MARCH 6.—"South African Gold Fields." By W. H. PENNING, F.G.S.

MARCH 27.—

APRIL 17.—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 31. — "The Monumental Use of Bronze." By J. STARKIE GARDNER, F.G.S. E. J. POYNTER, R.A., will preside.

FEBRUARY 14.—"Principles of Design, as applied to Bookbinding." By HENRY B. WHEATLEY. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., will preside.

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

APRIL 24.—"Craftsman and Manufacturer." By LEWIS FOREMAN DAY.

MAY 8.—"What style of Architecture should we follow?" By WILLIAM SIMPSON.

MAY 29.—"Persian Textiles." By CECIL SMITH.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

JANUARY 27.—"The Public Health in India." By Mr. JUSTICE CUNNINGHAM, of the High Court of Judicature, Calcutta. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

FEBRUARY 10. — "The Work of the Afghan Frontier Commission." By CAPTAIN MANISFOLD, R.A.

FEBRUARY 24.—"Facts regarding the religions of India, and their influences on the moral progress of the people." By SIR WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D. COLONEL SIR OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 16.— "The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras. SIR JAMES CAIRD, K.C.B., will preside.

MAY 4.—

The above dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE I.—JANUARY 30.—Yeast an organised cell.—Considerèd as a plant.—Why classed among plants.—How to be studied.—Phenomena connected with the growth of the cell.—Fermentation.—Kind of fermentation related to character and quality of yeast.—Conditions necessary to healthy growth.—Classification of the pure yeast cell among plants.—Its relation to the higher orders of plants.—Resemblances and differences.—How these are accounted for.—Its assimilating powers compared with those of the higher plants.—Yeast classed among the lower forms of vegetal life.—A fungus.—Its position among fungi.—A parasite or saphrophyte.—The characteristic features of its class.—Its relation to the other members of its class higher and lower in the scale.—Hyphal, sprouting and fission fungi.—Fungi capable of inciting fermentation and putrefaction.—Fungi capable of inciting alcoholic fermentation.—The yeast species defined.—Phylogeny.

LECTURE II.—FEBRUARY 6.—Mode of reproduction of yeast.—By sprouting.—By endogenous division.—The latter term defined.—Ascospores.—Conditions necessary to their formation.—Conditions of nutriment, of temperature, and of time.—The method of production explained.—Classification of saccharomyces according to their power of producing ascospores.—Those which form them.—Those which do not.—Critical examination of the various species from this point of view.—Saccharomyces and torulæ.—Analytical table of ascospore formation among saccharomyces.—Its practical significance.—Pure yeast secured and maintained by reference to it.—Impossibility of identifying species of saccharomyces except by ascospores.—*S. Cerevisiæ* capable of assuming typical forms of other species and conversely.—Top and bottom yeast.—Their resemblances and differences.—Character of beer determined by species of saccharomyces employed.—The essential differences explained.—Conditions necessary to healthy multiplication by sprouting.—Primary considerations affecting the question.—Fungal cellulose.—Protoplasm.

LECTURE III. — FEBRUARY 13.— The internal structure of the yeast cell.—Vacudes.—Granules.—Nuclei.—Nucleoli.—Gelatinous membrane.—Fat.—Composition of the cell.—Organic constituents.—Inorganic constituents.—Wort as a saprophytic food adapted to their supply.—Composition of wort.—Influence of malt upon composition and uniformity of wort.—The production of sterile wort.—Is it a necessity?—Is it possible upon the large scale?—Sterile wort as a medium for pure yeast culture.—The production of yeast from a single cell.—The test of purity.—Mode of preserving pure cultures.—The life of a yeast cell.—The transport of pure cultures.

LECTURE IV.— FEBRUARY 20.— Pure yeast in the brewery.—Apparatus employed in its production upon the large scale.—Method of manipulation.—Results achieved.—Is the method available in high fermentations ?—What advantages might it produce ?—The products resulting from yeast growth.—Fermentation. — Historical retrospect. — The various theories.—To what extent are they reconcilable ?—What practical advantages have been derived by their enunciation ?

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R.A., on Thursday evenings, February 2nd, 9th, and 16th.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 23...Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. R. F. Grantham, "Notes on Water-Supply, with special reference to Villages and Country Mansions."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Mr. W. Johnson, "Bricks and their Manufacture." (Second Paper.)

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "Alexander the Great."

TUESDAY, JAN. 24...Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. J. Romanes, "Before and After Darwin." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Sir Bradford Leslie, "The Erection of the 'Jubilee' Bridge carrying the East Indian Railway over the River Hooghly, at Hooghly."

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual General Meeting. Address by the President, Mr. Francis Galton.

WEDNESDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Walter Emden, "Theatres and Fireproof Construction."

Geographical, University of London, Burlington-gardens, W., 8 p.m. 1. Prof. W. Boyd Dawkins, "*Ailurus anglicus*, a new Carnivore from the Red Crag." 2. Prof. A. H. Green, "A contribution to the Geology and Physical Geography of the Cape Colony." 3. Mr. A. Smith Woodward, "Two New Lepidotoid Ganoids from the early Mesozoic Deposits of Orange Free State, South Africa." 4. Mr. A. Smith Woodward, "Some Remains of *Squatina Cranei*, sp nov., and the Mandible of *Belonostomus cinctus*, from the Chalk of Sussex, preserved in the Collection of Henry Willett, Esq., F.G.S., Brighton Museum."

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, JAN. 26...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. H. Statham, "Architectural Mouldings."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Herkomer, "My Visits to America."

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Mr. Arthur C. Cockburn, "Safety Fuses for Electric Light Circuits, and on the Behaviour of the Various Metals usually employed in their Construction."

FRIDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Mr. Justice Cunningham, "The Public Health in India."

United Service Inst., Whitehall-yard, 3 p.m. Captain H. de H. Haig, "The Pneumatic Dynamite Gun."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Joseph Thomson, "The Exploration of Masai-Land."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Lawrence Gibbs, "Pumping Machinery in the Fenland and by the Trentside."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Miss Helen Ormerod, "Abt Vogler."

SATURDAY, JAN. 28...Physical Science Schools. South Kensington, S.W., 3 p.m. 1. Mr. Herbert Tomlinson, "The Effect of Magnetisation on the Thermo-electrical Properties of Bismuth." 2. Mr. E. Van Aubel, "The Influence of Magnetism and Temperature on the Electrical Resistance of Bismuth, and its Alloys with Lead and Tin." 3. Prof. S. P. Thompson, "On a Water-dropping Influence Machine; and on the Factor of Safety in Lightning Rods."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture II.)

Journal of the Society of Arts.

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FRIDAY, JANUARY 27, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

SEVENTH ORDINARY MEETING.

Wednesday, January 25th, 1888; Lord SUDELEY, Member of the Council, in the in the chair.

The following candidates were proposed for election as members of the Society:—

Baxter, William Henry, The Lawn, Brixton-hill, S.W.
Collett, John Martin, 6, Brunswick-square, Gloucester.
Corke, Henry Charles, 178, High-street, Southampton.
Dunlop, Charles, 1, Ashbourne-grove, East Dulwich, S.E.
Ferguson, Reginald, 44, Belsize-park-gardens, N.W.
Leigh, Hon. Francis Dudley, Stoneleigh Abbey, Kenilworth, Warwickshire.

The following candidates were balloted for and duly elected members of the Society:—

Arthur, William Cresswell Ernest, Milligan-hall, near Taunton, Somerset.
Bernard, William Larkin, 7, Frederick-place, Clifton, Bristol.
Brocklesby, Harry Pearson, F.S.S., 9, Walbrook, E.C., and Clevelands, Stroud-green, N.
Eiloart, Frederick Edward, 40, Chancery-lane, W.C.
Fleuss, H. A., 19, Adelaide-road, Brockley, S.E.
Goldie, Sir George Taubman, K.C.M.G., Naval and Military Club, Piccadilly, W.
Hawkins, S. J., 18, Abingdon-street, S.W.
Hoster, Albert, 41, Cheapside, E.C.
Norman, George, M.R.C.S., 12, Brock-street, Bath, Somerset.
Rider, John H., Northern Telegraph Works, Halifax.
Samuel, Harry Sylvester, 80, Onslow-gardens, S.W.
Thompson, John, The Brewery-house, Albion Brewery, Mile-end, E.

The paper read was—

THEATRES AND FIREPROOF CONSTRUCTION.

By Walter Emden.

In dealing with a subject such as this, when even the sub-divisions of it, such as acoustics, site, exits, construction, legislation, &c., would each provide ample scope for a paper, it will be necessary, in order to embrace the whole in one paper, to speak only generally on much that I lay before you, and consequently to leave the details almost untouched.

During the last few years the periodic outbreak of fire in theatres has made no little stir, not unmingled with trepidation, both among those professionally associated with theatrical work, and among the general public; a very natural trepidation, as, during the past eleven years, the number of lives lost by fires in theatres, not reckoning those lost through panics, has been over 2,000. The instinct of self-preservation is impressing on laymen what the professional has known this long while—that the present condition of affairs in all our theatres, both as regards stage and auditorium, is not only provisional but untenable; that all the rules and regulations for the safety of audience and actors, rules and regulations more or less fully carried out, and as to which there is anxiety equally grave and general, by no manner of means do away with the necessity for a new system of stage mechanism. The regulations to ensure safety, placarded in all our theatres, are proof positive that the theatres are dangerous, and are clearly intended to facilitate the extinction of a fire that had broken out in a theatre, and the saving an audience in danger of being burnt to death. It is infinitely more important than making regulations to make theatres as absolutely fireproof as possible, and so to render the fires impossible.

As in the course of this paper I shall lay certain statistics and descriptions before you, it is only right I should inform you that I am for these much indebted to Mr. Alec Nelson, for the translation of the Asphaleia Co.'s pamphlet, to the report of the Philadelphia Franklin Institute, and to Messrs. Toelsch and Hexamer. I will first bring before you

some of the many statistics as to fires in theatres, together with a list of those in which loss of life has occurred. First, as to fatal fires. The following lists speak for themselves as to the necessity for some immediate reform :—

Theatre des Arts, Rouen, April 25th, 1876; 8 killed, 12 injured.
Chinese Theatre, San Francisco, October 30th, 1876; 19 killed, some injured.
Circus Theatre, Madrid, November 13th, 1876; 2 killed.
Mrs. Conway's Theatre, Brooklyn, December 5th, 1876; 283 killed.
Cronstadt Theatre, January 9th, 1881; 8 killed.
Opera House, Nice, March 23rd, 1881; 150 killed.
Ring Theatre, Vienna, December 8th, 1881; 794 killed. (Iron curtain was not let down. The fire was caused by the fall of a hanging lamp.)
Briggs' Theatre, Moscow, January 7th, 1883; 300 killed.
Temporary Theatre, Dervio, Italy, June 24th, 1883; 50 killed.
Theatre Govi Sanuke, Japan, August 28th, 1883; 75 killed.
Tinnevelly, India, July 28th, 1886; 100 natives killed.
Temple Theatre, Philadelphia, December 27th, 1886; 2 killed (firemen).
Opera Comique, Paris, May 25th, 1887; 77 killed (official report).
Exeter Theatre, September 5th, 1887; 188 killed.

There is thus a total of 2,056 persons who have perished during the past eleven years through fires in theatres, giving a yearly average of 186·9. This list takes no account of the number of lives lost by panics.

FIRES WHICH HAVE OCCURRED IN THEATRES FROM THE YEARS 1871 TO 1882.

1871	20
1872	13
1873	15
1874	15
1875	14
1876	19
1877	17
1878	20
1879	25
1880	23
1881	28
1882	23

THEATRES TOTALLY DESTROYED BY FIRE.

Three Times.

Her Majesty's, London.
Drury Lane, ,,
Covent Garden, ,,
Royal Theatre, Glasgow.
Imperial Opera House, Moscow.
Teatro San Pedro, Rio.
City Theatre, Namur.

Four Times.

Astley's, London.
Grand Opera, Paris.
City Theatre, Brunn.
National Theatre, Washington.
Barnum's Theatre and Museum, New York.

Five Times.

Bowery Theatre, New York.

LIFE OF THEATRES (ALL COUNTRIES INCLUDED).

From some statistics that were compiled in 1882, out of a great number of theatres of which the ages had been carefully ascertained, it was found that out of 252 theatres :—

Five were burned down before being completed or opened to the public.
Seventy were burned during first 5 years.

Thirty-eight	were	burned	from	6th	to	10th	years.
Forty-five	,,	,,	,,	11th	,,	20th	,,
Twenty-seven	,,	,,	,,	21st	,,	30th	,,
Twelve	,,	,,	,,	31st	,,	40th	,,
Twenty	,,	,,	,,	41st	,,	50th	,,
Seventeen	,,	,,	,,	51st	,,	60th	,,
Seven	,,	,,	,,	61st	,,	80th	,,
Eight	,,	,,	,,	81st	,,	100th	,,

Three only reached the age of 100 years.

It has been calculated that 616 fires in theatres had occurred up to 1883.

Sixty-nine	theatre	fires	occurred	between	1850-60.
Ninety-nine	,,	,,	,,	,,	1861-70.
One hundred and eighty-one	,,			,,	1871-80.

I will now deal with the state of legislation for theatres and public buildings.

The question of legislation at the present moment occupies the first place in the attention of the public, as well as in that of the managers and proprietors of theatres and public buildings. There is no doubt that under the present medley of laws there is very great and growing danger to the public, and much injustice and hardship to the proprietor. In any fresh legislation, and such legislation is now absolutely necessary, one of the great difficulties is, and will be, that so many public buildings after having been built and altered in accordance with the requirements of the present authorities, will, if they are to be made safe, have to be re-altered and possibly in some cases almost rebuilt, at the expense of the owners. It is a very hard case that men who have been allowed to erect and open buildings, and have had to alter them

to satisfy the requirements of one set of laws and authorities, should have at their own expense to again alter or rebuild these buildings. This is a serious difficulty, and it will be a serious injustice to, and a very ruinous tax on, the owners of this class of property, unless it is taken into consideration in any new legislation. Still the public must be made safe, and the sooner the difficulty is surmounted the better it will be, as at present it only grows, fresh public buildings being constantly added to the numbers already opened.

It seems astonishing that in 1878, when a committee was appointed to inquire into this subject—setting apart the fact that so far as loss of life from fire is concerned, London is the safest city in the kingdom—so futile and weak a course should have been taken as to legislate only for London instead of for the whole of the United Kingdom. Probably the committee did not use their own judgment, but were led by the evidence placed before them. The late catastrophes have demonstrated the danger of such a course as that of legislating for London only instead of for the United Kingdom. The danger in the provinces must naturally be greater, as fewer public buildings are built there than in London, and so there is less knowledge on the part of either the designers or the authorities as to what is necessary to be done before allowing such buildings to be opened for the use of the public. The better plan would have been to have placed the whole of the public buildings in the kingdom, together with funds for carrying on such a department, in the hands of the Lord Chamberlain, his office being at that time the only one possessing any of the requisite knowledge for dealing with the question. But as is usually the case, most of those who were most affected were not immediately interested, and they had no organisation to enable them to bring their wants before the committee, even if they knew at all of the proposed legislation. Probably it was only afterwards they found that, to their astonishment, a new law had been passed by which they could be harassed and made to expend large and sometimes ruinous and useless sums of money.

To erect and maintain buildings in a proper and safe condition for public use, it is necessary to have uniformity of regulations, which can only be obtained by legislation placing the whole of the administration under one department, where all the necessary knowledge for dealing with this subject would be collected. If that knowledge were collected in such a department, with a regular system of inspection, there is no doubt that its supervision would not only be useful, but would accomplish its object far better than that of any number of local bodies, under the many direct and indirect influences which they are placed. Otherwise legislation will press unequally and harassingly upon those who will have to suffer pecuniary loss through any such new laws.

There are many things which militate at present against theatres or public buildings being erected in a proper and safe manner. Among these may be taken two which have an immediate influence on the question. The first is, we have no authority competent to deal with the inspection and passing of theatres, and no expert inspection to see that such buildings are properly maintained. Second, the professional advice obtained from the architect may or may not be competent, and is always greatly handicapped. At present the profession is in an irresponsible position, and no proper and compulsory examination is required before any man can call himself an architect and place that word after his name, while anyone, whether he be a dustman or an educated man, can and is equally entitled to call himself an architect if he desire to do so, the title of architect is no guarantee for proficency on the part of those by whom it is assumed, and it must not be forgotten that theatre building is a speciality even among specialists. From these facts it is very evident that proper care and thorough knowledge and proficiency are alike equally uncertain or impossible, and the danger from the incompetency of such a muddle of clauses, and Acts of Parliament, which form the system (if system it can be called), that is now responsible for the public safety, is a great and growing one. The wonder is, not the numbers who have suffered, but that the numbers have not been greater. With a competent licensing and certifying authority, and with competent inspection, it would probably matter only in a very secondary degree whether the professional architect were or were not a thoroughly qualified man. To obtain such competence legislation is necessary, but before deciding in whose hands the authority shall be placed, there should be a thoroughly exhaustive Government inquiry, including the examination of all interested, whether experts or managers. Unless this is done, it is probable that another make-shift Act will be passed, increasing instead of guarding against

dangers, and years will again be spent and wasted in obtaining amendments.

We constantly hear from all sides misleading statements that this or that theatre is being built, or has been built, with every possible care and improvement, that it is as fireproof as it is possible to make it, but while we have such irresponsible authority and such imperfect knowledge brought to bear upon the subject, it is impossible to trust these statements, and when, as is the case sometimes, one of the belauded buildings is burnt down, many are led wrongly to believe that the building in question was properly protected, and as everything possible had been done that could be to make it safe from fire, and as it did not stand, they conclude that it is impossible to build fireproof theatres. It need hardly be said that such a conclusion is wrong; it is not impossible to make a theatre fireproof, but what, it will be found, has been done, has been to use fireproof materials for parts only of the building. It is a perfectly useless arrangement to build staircases, corridors, and certain floors in some fireproof material, and the rest of the work in wood or other inflammable materials. No building is stronger than its weakest part, and if fire can get hold of a portion of the materials employed, and collect sufficient heat, the building may as well have been erected entirely of such combustible materials, instead of only partly. If the whole of a theatre, or public building, be erected, which is quite possible, in fireproof materials —with brick or concrete walls, with the iron construction thoroughly encased in concrete over and under all the floors upon which the audience are seated, and the roof over them, as well as the corridors, passages, and staircases, of similar materials —the danger is gone, and the building, as far as the auditorium is concerned, will not burn, as there is nothing which will contribute to the body of flame and consequent heat. To complete the safety of the auditorium it is necessary that there should be a fireproof curtain to prevent the flame and gases which may be created by a fire on the stage from passing into it, and thus it is concentrated to the stage, and the firemen have better command over the fire. A source of great danger is the smoke and incombustible gases caused by a fire, as well as the great heat over the stage at all times. This must be guarded against by exhausts; no stage should be allowed to be used unless so fitted.

Electricity certainly should be used as the lighting medium, but it must not be thought that electricity is entirely free from risk. One theatre at least has been burnt down through the electricity with which it was lighted. Unlike gas, electricity gives no warning, there is no smell, and it will create fire of itself without flame being applied.

Considering the small number of houses fitted with the electric light, the following list shows how much care must be taken in its use, and too much thanks cannot be given to Mr. Musgrave Heaphey, C.E., who has made so thorough a study of this question, and who has for the Phœnix Fire-office drawn up a set of rules for the guidance of those installing, which rules are, I believe, now used by all insurance companies. My list will only show some out of the many accidents which have happened, and extends only over about two years:—

Temple Theatre, Philadelphia, entirely burnt down and two lives lost. Cause of the fire, the incandescent light. December 27th, 1886.

In Germany a theatre was set light to by the conductors firing the wooden casing, but the fire was seen and put out. 1887.

Star Theatre, New York, set fire to by the incandescent light.

In an Austrian theatre a fire occurred last year by the conductors bursting into flames.

There are two similar cases in London theatres, and also in a provincial theatre and concert hall, where the whole of the installation had to be removed.

In the Porte St. Martin Theatre, Paris, the conductors fired during the performance of Mdme. Sarah Bernhardt. A panic was caused, but it was allayed by the actors. This occurred so lately as November 27th, 1887. These are only some of the cases in which public buildings have been fired by electric light.

The fact is that electricity requires the greatest care in its installation, and the most careful maintenance in its use, and only under such circumstances is it good. The misfortune is that with electric light the public believing it perfectly safe are lulled into a false state of security, and those who use the light aggravate its dangers by failing to take the necessary care, and obtain the necessary advice in dealing with it, they imagining they need only use it to be safe. The opinion of the fire offices is that, with a thoroughly good installation carefully maintained, electric light is absolutely the best method of lighting, but without

such care in installing, the offices would, I believe, rather have gas, or prefer to withdraw from the risk altogether. There is also at present another serious inconvenience — the liability of the light to go out, which, in a public building, may cause very serious consequences. If, however, proper care has been taken with the installation, there is no doubt that it is the safest and the best light which can be introduced into a theatre, and with proper care in the maintenance it will remain so.

It is, however, the stage to which more particularly attention should be drawn. The present fire appliances are anything but in a position to cope with the great risk of fire, and they cannot be brought into use without some considerable danger to the person or persons employed in using them. Competent as the fireman may be, he cannot work with the same disinterestedness and steadiness in a place of serious danger as in a position which is safe. Again, smoke may either drive him away or render him incapable of dealing with the apparatus long before the fire has assumed such dimensions as to make it impossible for it to be mastered; for these and many other reasons it is necessary that all new devices for the better protection of public buildings, which come before the authorities and those responsible for the erection of theatres, shall have every attention given to examine them; at present none has been given. In the incipient stage of a fire one pail of water would be sufficient to extinguish it, provided that pail of water could be delivered on to the point of fire. Here is a valuable direction for invention; can it accomplish such an object? Lately there have been several attempts made. Amongst others there is a revival of the old perforated pipes; the new automatic sprinklers of various patterns; the open or non-automatic sprinklers; and the system called the "cascade." There is no doubt that an automatic sprinkler, or anything which acts only on a certain degree of heat being directly applied, is uncertain in its action, and is therefore practically useless for this purpose. A sprinkler that is not automatic is so far the best, although in New York, under the Building Act, public buildings must all have automatic sprinklers. In use it is the simplest, requiring no expert knowledge; a tap has merely to be turned to obtain the supply, and it has the advantage that the surrounding scenery can be so damped by the section of sprinklers turned on, as to thoroughly impede, if not absolutely to stay the progress of the fire. The sprinklers should be fixed in sections commanding the various portions of the stage, gridiron, and flies, both over and under, communicating with the main through valves fixed near the stage door or near an exit, so that from one safe position every portion of the stage can be dominated either in whole or in part. The exact distribution of such sprinklers must of course be decided according to the stage over which they have to be fixed, but they should be fixed closely together, about five to seven feet apart, or half the distance that they are fixed in warehouses, and a line of them should be placed over the fireproof curtain, so that the stream of water from them would keep it cool.

A difficulty in dealing with the sprinklers is, that the nearest to the main or supply pipe have the greater strength, and consequently they are weaker as they are farthest off; though this has been partially overcome by the cascade system (but up to the present this system has not been perfected), which proposes to overcome this difficulty by placing certain mechanism inside a long box or square pipe, perforated on all sides, by which mechanism the water is delivered with equal pressure throughout the whole of the interior of the said box, and then discharged more in a sheet than it would be by the sprinklers.

Turning now to a prevalent opinion that by soaking all the wood and cloths of a theatre with certain chemical solutions a safeguard against fire is obtained. This, in my opinion, is an error of the most serious nature. Theoretically, this soaking works beautifully, and in practice it does for a time secure immunity against the spread of fire. But for how long? Of the majority of these preservative solutions, it is a question if anything is left at the end of a certain time. They evaporate or sublimate in or pass off into the atmosphere. No one can say with any degree of certainty for what length of time a beam or a cloth will be fireproof as the result of soaking in any non-inflammable solution. Now miscalculations in respect to this may lead to the most terrible catastrophes. Even supposing that every year all scenic accessories, all costumes, the whole of the theatre, were soaked with preservative fluid—a plan inconceivable, impossible—then this method would probably nurse those that had to do

with the theatre in the lap of a false security, and lead to a careless playing with fire rather than afford any sufficient protection against it. A further point of the greatest moment, which must not be overlooked in this class of fireproofing, is that gas flames raise the temperature of wood and canvas in their vicinity to 140° Fahr., and dry them to tinder (although this would be obviated to a great extent by using the electric light). Obviously actual contact with a naked flame must, under such circumstances, produce results altogether different from those of the experiments usually made with preservative solutions. Thus, while believing that some good may be done towards preventing the spread of fire by the use of such solutions, when the fire is in an incipient stage, or that they may be of use in some special direction, it would be rank madness to trust to such a system of fireproofing, or to think that it would fireproof a building. It is the materials themselves which are used in the construction which must be proof against fire. The aim in such construction should be not to make some combustible material incombustible, but to use only fireproof materials.

This last point brings us at once face to face with the real virus of the plague with which our theatre of to-day is stricken. It is the stage—the whole planning and arrangements of which are not only dangerous, but fly in the teeth of the demands of modern art and of the spirit of the age—which requires a radical and immediate change for the better.

The theatre of the present day is still built upon the same principles as obtained in the 17th century. The tremendous advances in technical art since that period have left, practically, no trace on the theatre. We have contented ourselves with introducing, in a muddled and patchwork fashion, some inventions, such as gas, &c., without in any way changing the system as a whole. Every invention has served merely to widen the breach between the old system and modern requirements. Hence, every invention was not a reform, but a veritable change for the worse, so far as safety was concerned. For example, in order to accommodate larger audiences, we have been content to enlarge our auditoriums. But for the most part, the gangways and the staircases are as primitive to-day as they were 200 years ago. Gas has been introduced, but the theatre is still built of inflammable materials; the auditorium, even in most of the theatres recently built, is made up largely of wood, *carton pierre*, curtains, and a score of other easily inflammable things, to say nothing of the danger from the scene-dock and the stage, and above all, the traps and under-stage machinery, in which there is a whole forest of wood.

Fire is the most imminent and terrible danger in a theatre, but it is not the only one. The stage machinery of the present day involves serious dangers — if not to the public, at least to the *artistes* engaged. Who is there that has not heard of a stage-carpenter falling from the flies, and being carried off dead? that a fastening or a staple has given way, and killed someone on the stage? or that a trap fell in, and a number of people standing on it were seriously injured?

If safety regulations for every possible contingency were made, the present theatre would be like a beggar's garments, that show nothing of the original dress for patches. The spectator would no longer be able to see, or the actor to act, for rules and regulations. Artistic enjoyment would be at an end, and in spite of all this, safety would be still unsecured. Many of the regulations that are drawn up secure safety at the expense of æsthetic enjoyment. Now, to my thinking, there is here a fundamental contradiction. The safest theatre in the world is worth little unless it affords the fullest scope for the acting and the decorative art. And hence the question comes—Is it possible to have a theatre in which all the demands of art are satisfied as fully as those of public safety? Are the claims of both reconcileable without any injury to the one by the other?

Fortunately this question can be answered in the affirmative; but to accomplish it our theatres must undergo a systematic change, not only in regard to regulations for safety, but from the æsthetic standpoint. A rapid glance at the stages of evolution will prove this.

Among the Greeks, theatrical decoration was based in part directly upon nature, in part upon convention. The theatre of Dionysius, at Athens, *e.g.*, had for background on the one side, the actual rocks of the Acropolis, on the other the sea. Theatrical performances began just before or at sundown.

As has been said, at the same time theatrical decoration with the Greeks was based on convention. The stage was built in with a stone wall, in which were three doors. Whatever was supposed to occur in a room was played inside one of these doors. There was also the convention that those who

came from the harbour or from town entered from the right, those who came from foreign or outlying districts, from the left. So also it was the conventional plan for the chorus, generally of the common folk, to be placed in the orchestra, forming a semi-circle in front of the stage, whilst the heroes spoke from the logeion, or stage, and the gods from the theologeion, the roof at the back of the building.

There was no utilisation of nature for the purpose of decoration in the mediæval theatre. The latter was wholly and solely founded on convention. The English stage of Shakspere's time and the French of the same period had a like foundation. As a matter of fact, these had a kind of decoration, but it made no attempt at representing the particular locality it only indicated; the imagination of the public did the rest.

A revolution in all this was brought about by the rise of Italian opera and ballet, which ere long made their appearance at the courts of Europe. In these much stress was laid upon decorations and machinery, and to the influence of these we owe almost the whole of our present stage arrangements.

In the 17th and 18th centuries, however, the object of decoration was altogether other than it is to day. At that time one of the canons of poesy still was the astounding of the public by the thrusting upon them the last new marvel, whatever this might be. And this held good in reference to decorative art. There the chief effort was to strike, to overwhelm, but by no manner of means to represent nature. The conventional plan of the theatre was, therefore, scarcely touched. Its stiff, angular method was in harmony with the spirit of a time that loved to vamp nature, and to flank even its garden walks with theatrically designed borders. The queer, the grotesque, and not the natural, were the ideal of the decorative artists of the 18th century; transformations, spectral forms, flying dragons, fairies, will-o'-the-wisps, and the like, their best stock-in-trade. There was no thought of illusion; no one dreamed of trying to make the audience think they were not in a theatre. The theatrical was the antithesis of the natural.

The desire for realism which pervades the 19th century has completely changed the end and aims of modern decorative art. The decorative artist, like the dramatic, tries to play the part of interpreter between author and public. Both must now-a-days equally study the author whose work they present, they must understand him if they would give form to his teaching and to his thoughts. The decorative artist must, like the actor, know how to be in earnest. Actor and scene-painter alike must, above all, so labour that the audience shall forget that they are within the four walls of a theatre. But the stage methods of the present day prevent the realisation of such an aim, and the general public have to content themselves with the reflection that they are at a theatre. Everyone has had opportunities of observing the incompleteness of the arrangements in our theatres, while so far we have only been able to console ourselves by the thought that they must be thus, and that if better could have been done it would have been long ago.

Many will say it is easy to criticise, but much more difficult to improve; this idea is not difficult to controvert. A moment's thought will teach us that criticism lays the fonndation for positive work. The man of soulless routine who, devoid of all scientific or theoretical culture, goes droning along the conventional path, he alone is likely to be confused by criticism which would cut the ground from under his dull feet. To the practical man of scientific training, criticism gives the zest which finds the solution of many an enigma. And if hitherto criticism has failed to bring about a change in the condition of our theatres, that is not because such a change is impossible, but because it has not been strong enough, and hitherto routine has ruled the roast in theatrical matters, and science has been shut out of doors.

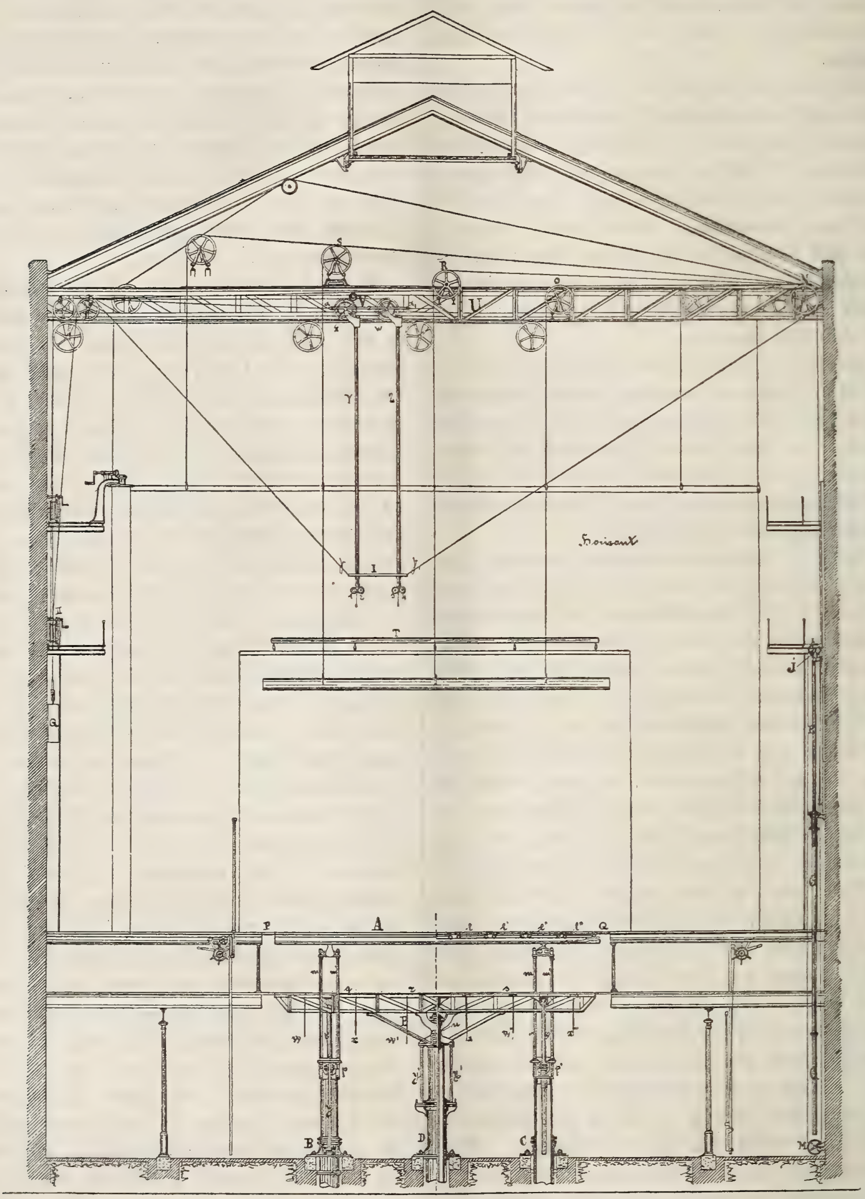
In this we still see the working of the old feeling against the theatre. Shut out from Society, it had to develop behind its back, and the memory of this former condition still clings to things theatrical. Truly, the actor of to-day is treated well enough by Society, he is no longer a vagabond and a stroller. Nevertheless, the stage still occupies an exceptional position; it is still to a large extent ignored by the State and by science. Science has turned industrial. She makes railroads, steam-engines, factories, and mills; she tins meat and condenses milk; but she has not troubled herself about the stage, and is only now waking to its necessities.

Hence it is that the majority of persons connected with the techniqne of the theatre are destitute of the smallest amount of scientific knowledge. They have all been through the mill; they know the whole routine of the theatre, as it was, is, and, as they think, ever-

more shall be, and they hand on their special knowledge to their descendants and successors. As result there has been practically no essential change in the planning and arranging of the stage for 200 years past; indeed, fundamental improvements were as little likely to be made under such circumstances as it was probable for a farm labourer to invent the steam-plough.

A number of scientific gentlemen in Ger-

FIG. 1.

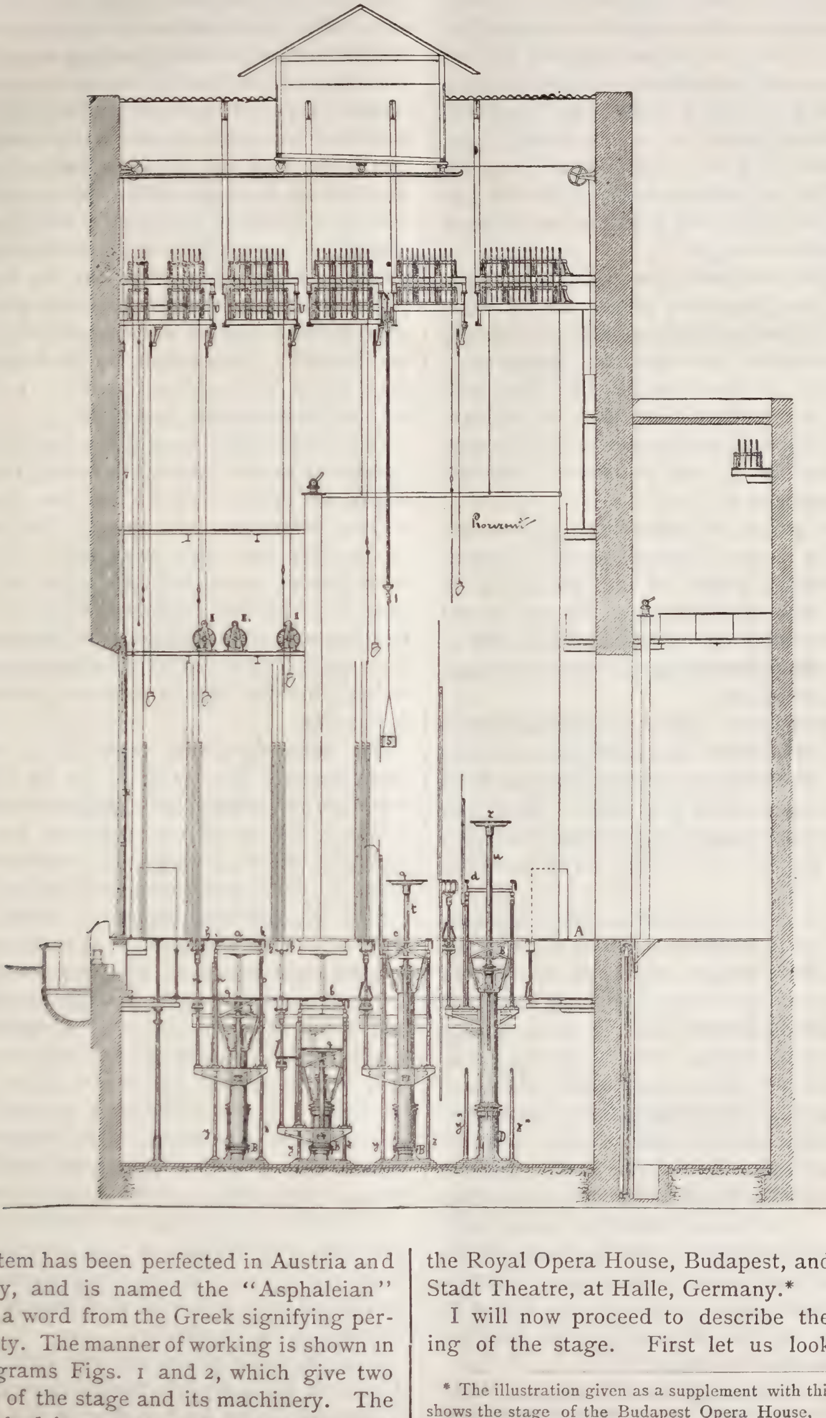


many, intimate as well with theatrical technicalities as with the æsthetic demands of modern art, have, quite independently one of another, for a long time had in view the possibility of introducing methods that should inaugurate an entirely new system, and once for all get rid of the blunders, or worse, of which I have spoken. The catastrophe at the Ring Theatre, Vienna, in 1881, led to an interchange of ideas among these men, and finally

to the formation of the Asphaleia Company, out of which the new system I propose to describe has sprung.

So far, I have dealt with the subject of the stage generally; let me describe the new system which embodies most of the foregoing wants.

FIG. 2.



The system has been perfected in Austria and Germany, and is named the "Asphaleian" system, a word from the Greek signifying perfect safety. The manner of working is shown in the diagrams Figs. 1 and 2, which give two sections of the stage and its machinery. The new method is now at work in two theatres, the Royal Opera House, Budapest, and in the Stadt Theatre, at Halle, Germany.*

I will now proceed to describe the working of the stage. First let us look at it

* The illustration given as a supplement with this number shows the stage of the Budapest Opera House, with the whole of the floor in motion.

from the point of view of security against fire. The Asphaleia stage has little probability of being burnt, for it is almost entirely made of masonry and metal. All the mechanism, the traps, and so forth, are of iron. The floor of the stage only is of wood (for if this were made of any other material, it would be useless for stage purposes) but the actual floor is of course very unlikely and very slow to catch fire, and it being of flat boarding, it must be exposed to an exceedingly high temperature for a long time before it can be set alight, while it is here in such position that the fireproof paints and solutions can be used to the best advantage.

The ropes and cords, usually made of hemp, can, in the Asphaleia stage, be of wire. Besides their being uninflammable, they do not become stretched and slack like hemp ropes, whilst they last much longer. As these wire ropes are not much dearer than the ordinary ones, and in actual work about two hemp ropes are replacable by only one wire, they are much cheaper in working.

Another point of importance for security against fire is, that the transmission of power throughout the whole of the machinery is hydraulic, not only increasing the pressure of the water supply for use against fire, but at the same time preventing the machinery from becoming overheated.

For illumination, the Asphaleia Company employs the electric light, but gas may also be used. One danger from the latter need not be feared, for the gas jets can be placed on the Asphaleian stage at any convenient height, and are placed some yards away from the cloths.

All these arrangements reduce any outbreak of fire to a minimum ; and, further, any such outbreak would only have the floor of the stage and the scenery to work upon. It would, with the fireproof curtain down, rapidly burn the scenery out, even if no attempt at extinguishing it were made, while the water apparatus, whether the sprinklers or any other kind, would, as has been already said, be greatly facilitated by the fact that hydraulics were used as the medium for the transmission of power, as its great pressure of water would be available in every part of the house for the use of the distributing apparatus. It is well understood by firemen that it is the force with which the water is delivered on the fire that insures the speedy mastery of it.

Despite this security against the possibility of a fire getting hold of any part of the house, yet other precautions are taken to protect the public against such eventuality. The stage is, of course, shut off from the auditorium by the usual massive proscenium wall. All the necessary communications are made through doors of iron. The roof is fitted with exhausts and a slide, which opens so that the incombustible and irrespirable gases can be got rid of. This slide is so constructed that it can in a moment be put into connection with the fireproof curtain of the stage in such a way that when the latter falls the slide in the roof opens. The two can be set in motion by turning any one of a series of stop-cocks, which can be placed in any number of different points required. These stop-cocks can be fixed in perfectly fireproof and safe places at the stage door, in the box-office, or even out in the street, and so forth. Hence it is highly improbable that these precautions for safety could be omitted from use even in a panic.

Besides complete security for the public, the Asphaleia theatre aims at securing complete safety to those engaged on the stage—to actors, carpenters, and so on. The bridges on the flies are done away with. For the taking up of scene cloths these are no longer needed, as all can be done from above. For the purposes of illumination the battens, &c., are replaced by a special "flying apparatus," which will be hereafter more particularly referred to.

Far more dangerous than the fly bridges nowadays are the traps, as far as concerns workmen and actors. In the Asphaleia theatre, however, the traps are perfectly free from danger. All use of ropes in connection with them is done away with, and with this of course the principal danger of their giving way, a much more frequent occurrence than many people imagine. The trap mechanism in the Asphaleia theatre is of great strength and made of iron. The only accident that could affect it would be if, after long continued use, any portion of the water pipe rusted through, and the water then escaped. An inspection of the stage by the master carpenter, even of a most superficial kind, could not, however, fail to notice a damage of this nature in an iron tube, and if this were not the case, the escape of water would draw attention to it by the slow and gradual falling of a raised trap, any sudden collapse of a trap, however, being impossible.

The greatest improvement introduced by the Asphaleia Company into theatrical mechanism is, however, in the centralising of all direction

and superintendence. The whole of the skilled labour required to work the machinery is in the hands of one man, with an assistant. From the place where he stands he has a complete view of all the stage, and is able to set in motion at any given moment any given part of the machinery. This result could only be attained by such a system as this, which replaces hand labour by that of machinery.

In applying power to work the stage, hydraulic pressure is not only safest as a protection against fire, but it is the simplest and least dangerous in working, as well as the most noiseless, and although its first outlay is greater it is really the cheapest in the end, as it reduces the number of men employed by one half, or even more. The hydraulic pressure necessary to drive the machinery is six atmospheres. In towns that have no pressure, or that have too low a pressure of water, a motor engine can pump up during the daytime the quantity of water required, and the same engine will be free in the evening for producing the electric light, and for other purposes, such as ventilation, &c.

All these advantages will show how thoroughly the Asphaleian stage system has been considered, and how greatly advanced it is to that used in our present theatres, even from a mechanical point of view. It is claimed for it that it is yet further in advance of other theatres from the artistic point of view.

Let us look first at the stage floor. This is so arranged as to open in every possible direction, and that without any special preparation being necessary. Every trap goes right across the stage, and is in this direction divided into three parts. Each one of these three parts rests on the piston of a hydraulic press. It can be not only lowered but raised, either by itself or with the other two, without any special preliminary arrangements. In like manner the whole floor of the stage, either in whole or in part, can be raised or lowered. These movements are effected by the opening or closing of a stop-cock, which regulates the flow into the cylinder of the hydraulic press of water, which is at a certain constant pressure. When the cock is turned to its central position, turned neither to the right nor to the left, the floor of the stage or the particular trap is stationary at any given level. But, further, it is possible to raise or to lower, now one side, now the other, of the floor to a given extent, and thus to get a see-sawing of the whole floor, or of any one of the sections of it, with a precision and a perfect absence of danger attainable in no other way; beyond this there are many other possible combinations, too numerous to describe.

Each section of the floor of the stage can be fixed in an oblique position, with its top and bottom at given depths. The traps can be arranged one after the other as a succession of steps, bridges, balconies, mountains, ships, as in "L'Africaine;" the storeys of a house, as in our melodramas, can be arranged—as they certainly cannot now—in a moment, and with perfect safety, and all this without any considerable preparation being required.

As a consequence of this, the clumsy timber-work, set pieces, tressels, and the unsafe, cumbersome, and inflammable building up of scenes, now in use in all theatres vanish. The arrangement of the Asphaleia stage replaces these perfectly in every way. Another advantage is that, since no cumbersome timber work is needed to be built up, and it is possible in a few seconds for any part of the floor of the stage to be placed at the required height or depth, the unevenness of the ground in those cases where the dramatic situation requires it can be obtained in a few seconds.

This easy representation of uneven ground strengthens the possibility of illusion, and gives boundless scope to beautiful groupings and posings, impossible on the plain, ordinary stage.

The trap arrangement of the Asphaleia theatre is, therefore, not to be regarded as mere traps in the same sense as hitherto understood. These Asphaleian stage traps are the means of arranging the floor of the stage in any particular way that may be necessary, and as such they should be indispensable to every theatre.

Between each of the sections of the stage just described in the Asphaleia theatre are two slides through the space left between them through which a whole scene can be raised to any required height. Besides these there runs down each side of the stage, from front to back, a similar slide, through which wings can be erected. Thus it is possible to raise up from below the stage into view of the audience a completely built scene representing a room.

It is easy to see how all this facilitates changes of scene, and shortens waits. The whole mechanism of the scenery can be set in motion simultaneously with the traps at the same moment, so that as a scene comes up from a trap, another can be withdrawn. For scene changing this is of inestimable value.

The flying apparatus of the Asphaleia theatre is in complete harmony with all modern requirements, nevertheless it is exceedingly simple. It can be moved anywhere it is wanted, not only in straight lines, but in curves or in any direction required.

Two important inventions remain for consideration, the horizon and the new method of lighting. Until the present time it has been customary in the theatre, whether a closed room or the open country is to be represented, to diminish the breadth as well as the height of the stage as it receded from the footlights. The wings, right and left, are nearer together at the back of the stage than they are in the front; the floor of the stage rises at the back, whilst in the same proportion the borders and floats hang relatively lower.

As far as built-in rooms are concerned, this is all right enough, although by the gradual sloping upwards of the stage it makes the perspective, even in these, false. But in open-air scenes this arrangement is in the very teeth of actual fact. If I look at anything out of doors, the breadth of the surface visible increases the further it is away from me. The horizon is not the narrowest but the broadest part of my visual angle.

To realise this effect the back of the stage of the Asphaleia theatre is much wider as compared with the opening of the proscenium than it is in ordinary theatres. Its whole area is surrounded by a continuous cloth scene, on which there is painted a sky called the horizon, which runs round the back of the stage and both sides, as far forward as the second grooves, and in order to produce the effect of an uninterrupted surface, the corners are rounded off very gently and carefully, by which arrangement the eye of the spectator is not brought up short by the wings, but he can look away out to the right and to the left.

It is no longer necessary, as is generally done to-day, to build on heaths with lines of rock or trees. It is, by this system, quite possible to represent boundless plains and the illimitable expanse of the sea.

This "horizon" not only helps in the illusion, as to the stretch of land or sea to right or left, but it reaches so high that ugly and dangerous sky borders are no longer needed. Hitherto, nothing has so jarred on the imagination as these blue strips of various tints, which never in any way produce the illusion of the immensity of the heavens. This the horizon—so far as a picture can—does, by representing a uniformly illuminated surface that gives the same impression as the sky.

For any depicting of landscapes the "horizon" should be therefore indispensable; again, it facilitates the setting of the scenes, for as it is always in place, all that is necessary in order to represent a garden or a street, or some place in the open air, and so forth, being to push up through the slides the necessary trees or houses, &c.

Even with this the advantages of this important invention are not exhausted. The rollers in which the horizon hangs are those of a panorama; not only can it, like a panorama, be run on the same rollers, but the horizon itself makes a panorama on which can be shown the different aspects of the sky, from the deep blue of Italy to the fogs and mists of the north, from the fleeciest clouds to a sky heavy with thunder, or from night to day. Thus, at a moment's notice, that is now possible which until now could only be produced after long and expensive preparation, and could never be effectual, because of the sky borders. A sky can now change its nature during the playing of a scene, if necessary to the action of the play.

The invention of the system of illumination is not less important than the invention of the "horizon." A most important improvement is the doing away with the rows of gas battens and floats, the great and fertile source of most theatre fires. This advantage cannot be too highly estimated.

Footlights, which represent in point of time the days of candles as a method of illumination, could not up to the present time be dispensed with, because the lighting from the side is carried so far up the stage that the actor who comes down to the front is before the main body of light, and if there were no footlights he would be only illuminated in the rear, whilst his face would be in shadow. In the Asphaleia theatre, by a special arrangement of the proscenium, the side lighting is carried so far forward that it is always in front of the actor. By this device the nuisance of the footlights is altogether done away with.

These are in broad outlines the chief advantages of the stage arrangements of the Asphaleia theatre, as compared with those of the present day.

Any one without prejudice who compares the Asphaleia stage with the present system must be struck with the fact that it fulfils conditions long wanting in our play-houses,

while it is in every way more safe. In fact, it can be absolutely fireproof, while at the same time it is possible, artistically, to carry illusion to the highest degree of perfection realisable in the present condition of science.

Although the Asphaleia theatre is, in its initial outlay, more expensive than one of the same size of the ordinary type, it is much cheaper in its actual working. The mere insurance premium would be far less, in view of the greater security against fire. The waste in materials, in the construction of set scenes, would be reduced to a minimum. The "horizon" will serve where nowadays a number of new scenes, with a whole number of borders and wings, would be necessary; and the formation of the stage does away with most of the cumbersome and wasteful sets which now have to be built up.

Lastly, while the saving of labour for working the stage amounts to at least 50 per cent., only one-tenth of this saving is to be deducted for the necessary outlay upon the extra skilled machine labour required.

Thus, from the mere business point of view, the Asphaleia project is worthy of the closest study; but where the greater question of safety to the public is so closely affected, it is absolutely necessary to give this system the best and most earnest attention.

A working model of the Asphaleia theatre, one-tenth scale, with the machinery, scenes, hydraulic apparatus, &c., lent by the Asphaleia Company, was exhibited in the library.

Translation of letter from the Director of the Buda Pesth Opera House:—

To the Asphaleia Company.

I have much pleasure in availing myself of the opportunity to make this public declaration, that the selection of the Asphaleia system for the Royal Opera House in Buda Pesth has been in every sense a fortunate one.

Not only is the theatre, as a consequence, made completely fireproof, but all the work of the theatre has been in every way facilitated and advanced. Throughout the four months during which the Asphaleia stage has been in action at the Royal Opera House in Buda Pesth, there has not been a single difficulty, or a single hitch in its working.

All theatrical effects produced on other stages have been proved practicable on that of the Asphaleia. But, in addition to these, a number of other effects, not possible on ordinary stages, notably the "horizon," and the whole system of the traps have been realised. Even the most embittered foe to the Asphaleia system must admit that such ravines, such streets, such cathedrals as we can now present, are not to be thought of on any other stage. And the whole working is noiseless, steady, easy, swift, of perfect precision, and perfect cleanliness. The hydraulic presses have not given rise to the least unpleasantness, dampness, or anything of the kind.

The under-stage region is cleanly to an extent such as appears impossible in other theatres.

Nor must it be forgotten, in conclusion, that on the side of cheapness the Asphaleia stage has scored very heavily. The amount of labour-power it requires is much less than on other stages, and thus the possibilities of the Asphaleia are much wider than theirs.

From September 12, the day on which the first trial of its scenic working was made, until February 1st, inclusive, twenty-one operas and four ballets were put on, representing an amount of work impossible in the ordinary theatre.

In a word, I can conscientiously state that the Asphaleia stage has established itself quite firmly in the Buda Pesth Opera House, and that, for my part, I am satisfied that I have taken the initiative in an invention so full of important consequences to the stage.

BARON FRIEDRICH PODMANIEZKY,
Director.

Buda Pesth, February 2, 1885.

DISCUSSION.

The CHAIRMAN said all would agree that this subject was one of the greatest importance. The Society of Arts had always taken a prominent part in endeavouring to minimise the danger of fires in theatres. In 1883, a committee was appointed to consider this matter, and on their report being laid before the Council, a public meeting was called and a series of resolutions were passed. Soon after that a Parliamentary Committee was appointed, when a large amount of information was obtained, and since that time several papers had been read on similar subjects. It was impossible to point to any danger more terrible than a fire in a theatre, especially when accompanied by the panic which so often ensued. We prided ourselves on the civilisation of the 19th century, yet on looking round there were very few theatres, indeed, which were not filled with fearfully inflammable materials, material that daily became worse by being subjected to the heated products of gas. Parliamentary action had been alluded to, but unfortunately it was very difficult to obtain, especially at the present time, and the British public, although occasionally roused by a great disaster, soon went to sleep again, and no steps were taken to reduce this fearful danger. Such papers as this, therefore, were of the greatest importance, suggesting some new plan of action. The subject might be divided into two parts. First there were the new theatres about to be built, and secondly the existing theatres.

No doubt prevention was better than cure, and Dr. Percy and other authorities had stated that a theatre could be made fireproof, providing everything was made uninflammable, not a portion only. Unfortunately, stage managers could not attend the meeting on account of the hour, but several gentlemen were present who were practically acquainted with the subject. Several questions of importance were raised—that of electricity *v.* gas, and how far wood and canvas could be rendered uninflammable by chemical solutions, as to which some doubt had been expressed. Then there was the question of sprinklers and cascades; the appliances of the stage, and the very important one of exits. He thought Mr. Emden had laid rather too much stress on the danger which might attend the use of electricity. He had mentioned several theatres which had been burnt down owing to faulty installations, but he thought those competent to deal with the matter would agree that if electricity were properly applied, there was practically no danger. If persons were employed who knew nothing about the subject, and proper precautions were not taken, of course danger would ensue; but if the wires were properly covered, and there were the proper number of "cuts-out," there could be no safer light than that of electricity, and it certainly eliminated the danger arising from the heated products of gas.

Mr. E. C. Robins said he had not had much experience in theatre building, for although he designed the Denmark Theatre for Leicester-square, it was never carried out. He hoped there was a time coming when a new course would be struck out. He had in his possession a valuable French work on theatres, in which plans were given of every important theatre in the world, with interesting details as to the fitting up of the stages. Some of these were so elaborate that they looked more like lace machines, but they all seemed to have the radical defect to which Mr. Emden had drawn attention, that none of them could be said to be fireproof; in fact, the wonder was, with such complicated work, that fires did not take place more often. Figures had been given with regard to the losses by fire which were most startling, and the publication of these figures would, he hoped, attract more attention to the subject. As an architect, he had good reason to believe that buildings could be made fireproof, theatres in particular; but the question always arose as to the expense; that was the secret of the whole thing. A theatre did not always pay, and they were burnt down so often that people imagined that they had very short lives, and that therefore it was not wise to erect a very elaborate and expensive building which was supposed to be fireproof but was not. When it was understood that the lives of theatres might be prolonged almost indefinitely if they were fireproof, a better state of things would prevail. The idea had been that if the floor and staircase were fireproof the whole building was fireproof, and people were deceived with the idea that, if they used materials which would not burn, the building was safe. If any one would notice the effect of a large fire on a wooden beam, say four inches square, and on a wrought-iron girder, it would be seen that in one case the beam remained until the end of the fire, and might often be used again, whereas the girder was twisted about like a ribbon, and was of no use whatever. The same thing might be said with regard to stone staircases. Directly the heat of the fire, and the water came upon it, the stones split into shivers. It was made clear, however, by the paper that theatres might be rendered fireproof, and if this were done properly, they would be less expensive in the end.

Mr. T. Blashill said he had considered it only respectful to the Society of Arts and to Mr. Emden and other architects engaged in carrying out theatres, with whom he came into official communication, that he should come to hear this paper, but he did not know that he could add anything useful to the discussion. Perhaps someone would be able to state what was done in foreign countries, where more attention was paid to these matters by the authorities, and he thought this would be both useful and interesting.

Mr. S. Chatwood said that though he had never built a theatre, nor even been consulted as to the mode of making one fireproof, he had been fighting with fire all his life, and therefore knew something about the subject. He agreed with most of Mr. Emden's conclusions, and thought one could not do better than employ iron for the principal parts of the structure, if it was encased so that the fire could not touch it. When iron pillars were left exposed, as was often the case, they were mere fire traps, not half as good as if made of wood. He took a little exception to the remarks on making wood fireproof. You could not make the seats and the floors, and a great deal of the fittings of iron or concrete if the place was to be comfortable, and it was therefore desirable to consider whether it was possible to make the wood fittings non-inflammable. Now there was no doubt you could make wood so fireproof that if you built a fire about it, when the fire was out the wood would still be left. This could not be done by merely soaking it, and it came again to a question of cost. If you wanted a building absolutely fireproof you must not hesitate about the cost. If the wood-work was all dressed and prepared in a receiver, from which the air could be exhausted, and left there for a fortnight; then placed in another tank in a solution of tungstate of soda, and left for a month, he would warrant that after that Mr. Emden would not be able to burn it.

Mr. Lascelles-Scott remarked that, although you could make any organic substance, such as wood or muslin, uninflammable, you could not render it incombustible; you could not take from it the carbon

and hydrogen, and you could not prevent those elements, when subjected to great heat, giving off an inflammable gas, which would burn either on the surface of the so-called fireproof material or a little way from it. But it was quite possible to prevent such material taking fire, and, that being granted, a great step would be accomplished, if it were enacted that in future all materials used in theatres, or 90 per cent. of them, must be fireproof. A fire always began in a small way, and might be put out with a pail of water, but one integral principle, that of convection, was neglected. When you had a stream of heated air pouring up from the burning material, and cold air rushing in below, that made a small fire into a blast furnace, and nothing could then save a theatre or any other large building. If that convection were absolutely prevented, not by sliding roofs and making holes in the top of the stage and auditorium where they ought not to be, but by having an absolutely fireproof roof, which could be done without expense, by having it of iron, or any material kept soaked with water or certain chemicals, there would be no difficulty in smothering a fire, whether it were only small or tolerably large. He agreed that stone and iron were most dangerous materials if left unprotected. There was no reason in the world why a large building like Whiteley's should not be so constructed with iron and concrete, properly protected and divided, that, even if a fire broke out, it should be confined within a very limited area. The principles of the Asphaleia theatre were no doubt the ideal of perfection, but if all the existing theatres had to be swept away or rebuilt on the Asphaleia system, something like four or five millions sterling would have to be spent. Many things might be done in Germany, that much-governed country, which he did not think would be possible in England. He saw no practical difficulty in adding a few simple rules to the Metropolitan Building Act, so as to make it apply to the whole country, and so to gradually improve theatres until at last even the ideal might be reached. He had mentioned on a previous occasion that an ordinary soda-water syphon was one of the best fire extinguishers, though it was rather awkward to use, on account of the downward current, and he now found that a patent had been taken out for something of the kind, and he believed it would be found much more valuable than many of the much-vaunted grenades.

Mr. T. VAN PUTTEN asked whether Mr. Emden relied entirely on structural arrangements for protection against fire? He had referred to the use of appliances, but did not say which he would recommend. From what he had seen and heard, he thought the hand grenades were very valuable, not that they would put out a large fire, but every fire had a small beginning. A grenade was practically a bucket of water in a condensed form, strengthened by the addition of chemical compounds, and he would ask if it would not be well to have the system of sprinklers charged with chemicals? He did not think the arrangements of scenery which had been described, widening out at the back, would be satisfactory to that portion of the audience which was placed at either side of the house, since they would lose a great deal.

Mr. DOUGLAS P. RODGERS said he had been engaged for the last twenty years in fireproof construction, and was glad to endorse the suggestions made by Mr. Emden, and to hear that he had made up his mind that whatever theatres he designed should be thoroughly fireproof. One great difficulty he met with in inducing people to adopt fireproof construction was that the insurance companies would not make any deductions in the premiums on that account. Of course this cost more, though not very much more now, for the cost was very much reduced, but the insurance companies would not make any allowance. They seemed to go on the principle that if there were no fires there would be no insurances, but he had noticed that in their own buildings and investments they always adopted fireproof construction. In looking over the ruins of the Grand Theatre almost immediately after the fire, he found it was quite useless to make portions of a theatre fireproof; the incombustible portion remained, but the tiers, the roof, and everything made of wood was destroyed. The fire burned everything there was to consume, and then went out. If the tiers, roof, and all had been of concrete, the theatre would not have been burned, some of the scenery and decorations might have been burned, but the theatre would have remained. He found that brick offered the greatest resistance to fire, and concrete came next, depending very largely on the materials of which it was made. Burnt clay or ballast, mixed with Portland cement, was the best. In London this was more expensive than it would be in many parts of the country. A modification had been introduced whereby the lower part of the floor was made of brick and the upper part of a cheaper kind of concrete, and that promised very well. The sections of flooring shown by Messrs. Doulton were very excellent, but he thought there would be a certain amount of lateral thrust. He believed the system originated in America, and he was told that there they always put tie-rods through. Mr. Robins and Mr. Chatwood said cost must not be considered in fireproof construction, and he wished architects would adopt that principle, which would be for the benefit of the whole community. Although it might cost more in the first place to build a theatre fireproof, it would be much cheaper in the long run. The cost of the fire at the Grand would be some £10,000 or £12,000, and there was all the cost of the insurance, which was really lost, but if they had spent a few thousands more and made it really fireproof, they would still have had a theatre instead of a wreck. A theatre was about the easiest building to make fireproof. The dividing

partitions of the boxes might be of a permanent nature, brick on edge, and if these things were made of uninflammable material, a great source of danger would be removed. Wood-flooring might be laid down in short lengths, with a dovetailed groove laid in cement, and that would be impossible to burn; in many of the seats the frames were of cast-iron, and there was little to burn but the stuffing. A theatre built on these lines, with nothing about but a few curtains and stuffings, could not be set on fire, and it would not be necessary to protect the iron to such an extent as in a warehouse, where there were large quantities of highly inflammable materials. Some of the cast-iron columns in the Grand Theatre stood through the fire and remained intact, and he thought it would be wasting money to encase such columns. The beams should be encased for the sake of appearance; but a cradling of wood, with lathe and plaster, would be sufficient. Such a theatre as he had suggested could be built very cheaply. If they could once get people to see that fireproof construction was cheapest in the end, and could induce the insurance companies to lower their premiums for such building, a better system would soon be introduced; but he had tried in vain to get the companies to do this, at any rate, with regard to ordinary dwelling-houses.

Mr. ALFRED BARNARD agreed that the insurance companies did not appear to encourage people to build what were supposed to be fireproof buildings, although to his mind there was not such a thing, especially as regards a theatre. There were 40 or 50 theatres in London, and he did not suppose that more than two claimed to be fireproof, and he believed that those who did not claim to be so were equally safe, for reasons which had been pointed out. Stone and iron were not really fireproof, and they were the materials chiefly relied upon. All places of public amusement should be provided with sprinklers—not automatic, because they would not act until a certain temperature was reached—but mechanical sprinklers which could be turned on at any moment, and in any direction. If they were to cover the stage scenery with sprinklers, and ruin it by excess of water, their object would be defeated. There should also be some portable means of checking a fire ready to hand, such as grenades, although they had been somewhat derided.

Mr. J. H. HEATHMAN said he had had great experience in providing fire-extinguishing appliances and hydrants, and though there were plenty of such things available at a low price, they were not much used. At the Grand Theatre he put in the appliances, and saw they were all in good order, but within three or four days after the building was opened, he went again, and found every length of hose uncoupled from the hydrant, and carefully rolled up; and even the pumps were taken out of the pails and hung up on the wall. He remonstrated with the fireman, but in vain. On looking over the ruins he was convinced that proper use had not been made of the appliances, and he came to the conclusion that if they had been put to work properly, the theatre might have been saved. In the case of the Exeter Theatre, he felt that the licensing authorities were seriously to blame. He had to carry out the arrangements, and put in two hydrants, with forty feet of hose to each. He insisted that there ought to be seven, but he was told to mind his own business; that the licensing authorities only required two. When passing through Exeter, he visited the place, and seeing that such a provision was merely absurd, he spoke about it again, and in the result, was ordered to send down another forty feet of hose to each hydrant. There were, therefore, two hydrants, with 80 feet of canvas hose to each. He was positive that if there had been a hydrant on the flies of that theatre the men, instead of cutting the ropes, would have put on a jet of water and put out the fire. Forty-three people were found dead in their seats suffocated with the smoke, because the men in the flies had no means of putting out the fire except cutting the ropes, which caused a rapid movement of the air, and made the fire burn brighter. They tried to run out a length of hose, but it was not connected to the hydrant. He knew another case where the Metropolitan Board of Works obliged the proprietor of a theatre to spend £1,400 on structural alterations, but said nothing whatever about the meaus of extinguishing a fire. They made them pull down all the partitions and open up gangways, under the impression that the theatre was going to be a fiery furnace, but it was no more necessary to treat theatres as dangerous structures than ordinary dwelling-houses. They talked about fireproof curtains, and overlooked altogether the most vital point, the prompt extinction of a fire. If you had a fireproof curtain you frightened people, and unless there were to be a furnace on the stage it was not wanted. But there should never be a furnace on the stage. If the authorities would see that all buildings should be fitted with fire-extinguishing appliances, and that they should be kept in order, and so arranged as to be available in the shortest possible space of time, the public would be more assured than by any amount of fireproof construction or curtains. Smoke was more dangerous than fire, and no fireproof curtain had yet been invented which was smoke tight.

Captain SHEAN thought the Chairman was quite right in pointing out that this subject should be divided into two heads—the theatres of the present time and those of the future. Just now there were about 100,000 people nightly visiting the London theatres, and the first question was, were those theatres safe? and if not, how could they be made so? As a matter of fact, they would not be made safe until legislation enforced a fresh code of rules. It was supposed that the Lord Chamberlain exercised jurisdiction; but last

Boxing-night, at Covent Garden Theatre, chairs were placed in the gangways. That was known to be against the rules, and every one could see the danger which it involved in case of a panic. If a proper code of rules was adopted, almost all existing London theatres might be rendered practically safe. There were two, and a third which was doubtful, which could never be rendered safe, and must be altered. With regard to the theatres of the future, it was possible to construct them fireproof, but there must necessarily be a quantity of combustible material in the shape of scenery. Even two or three papers lit in the middle of that room would cause enough smoke to smother a great many people. The question was would it pay theatrical managers better to build theatres at an enormous expense, nominally fireproof, or to build them not quite so expensively, but properly looked after with a staff of good practical men, so that a catastrophe would be an impossibility. In London there was a serious deficiency of water power, even for the extinction of ordinary fires. The pressure in the Strand was not sufficient to carry the water to the roof of any theatre, which was the most dangerous point, and unless such pressure were provided it would be impossible to put out a fire in the roof, and consequently the theatre might be destroyed. Such a thing had occurred in many places, and would continue until theatres were compelled to adopt adequate means for fire extinction. Although influential meetings like the present might draw attention to what was necessary, he was afraid the danger would remain until another catastrophe roused public opinion again.

Mr. D. RUDDLE said houses might be made fireproof with very little addition to the ordinary cost. At the Houses of Parliament Sir Charles Barry adopted tiled arches, constructed, in some cases, of two inch thickness, in some of three, and the whole building was practically fireproof. The rooms were all lined with wood, mostly oak, and on one occasion when a fire occurred in one room, that was burned out, but the fire did not extend. If attention were paid to tile or half-brick arches, houses might be made fireproof at very small cost. He agreed with what had been said about the effect of fire on stone and iron; iron might be used, but it should be cased with bricks or tiles. You could not make it absolutely fireproof, but it should be used in small substance, and the building made fireproof in other respects. He would also point out that ventilation was very frequently the means of conveying fire from one portion of a building to another.

Mr. EDWIN ROBBINS described a method of fireproof construction which he had been using for some years, consisting of the use of gauze wire in connection with various kinds of cement and concrete, for which he had taken out several patents, some of which were particularly suitable for decorative treatment.

Mr. PHILIP BRANNON said he had devoted a large portion of his life to the subject of fireproof construction. Buildings could be made absolutely fireproof at very little cost, whereas the cost of fires was immense. From calculations he had made, he found that, if we could set apart the money lost by fires in this country, in thirty years it would extinguish the national debt. In the dome of St. Paul's Cathedral a specimen of his work could be seen, that being protected by an internal skin; whilst at Cambridge the room in which the Pepys Library is kept was protected by an external skin. He had built some cottages—not models—the doors, walls, and staircases of which had been exposed to a white heat for four, six, eight, ten, and sixteen hours. It was, therefore, a crime against society to continue to place the lives of men, women, and children in jeopardy, when with a very little expense, and in some cases none at all, buildings could be made absolutely fireproof.

Mr. W. K. GILBERT produced samples of a material, which he had just received from Paris, where it had been adopted by twelve theatres, and was highly approved by the Prefecture of Police, and asked permission to leave them to be tested.

Mr. EMDEN, in reply, said he had no over-roof to his theatre; the roof was entirely of iron and concrete, thoroughly encased, and each tier was constructed in the same way; there were no wooden floors whatever, and there was no need for any. The only wood-work was in the doors and windows, and they were prepared with a solution. He might remark, however, that the scenery at the Grand, and also, he believed, at Bolton, was partially prepared with solution, which did not say very much for it. In the staircases and corridors, and all other parts of the house, he used concrete made of coke breeze and cement, which was filled in between the girders and joists, and overlaid with a concrete made from iron slag and cement, called Eureka concrete, and underneath that a plaster on wire. The iron was thoroughly encased by a concrete, in which there was nothing which could burst into flame. With regard to the Eureka concrete, he might say that there was a fire at their factory, and the whole building was burned down, except that portion which was lined with their own material, and there was a large tank, in which the water was all boiled away, but the tank, which was made of this concrete, remained intact. He had lately been over nearly all the new theatres in Germany, and had seen a great many new plans, but he found no theatre fireproof He did not believe in Mr. Heathman's idea; he did not want to take medicine, he wanted to avoid the disease. The best way to do that was to make the building fireproof, and then appliances might be useful to put out a fire amongst the scenery, but if the apparatus did not succeed, it might burn out with safety to the audience. With regard to water-

power, the London Hydraulic Power Company were now putting down their system, by which with the small injector pipes a pressure could be put into the fire mains which would exactly double the power or head of water in the pipes. He believed it was now all down the Strand, and capable of being used by all the theatres. No doubt a system of sprinklers was wanted, for it was impossible to always prevent accidents, and you wanted a safe and easy means of getting at fires, which would work even if a fireman did run away. If a theatre were burnt down with nobody in it, it was not of so much importance; the manager or owner ought to see he had a thoroughly reliable man in his employ, and that he properly attended to his work. But when the public were in the building, then was the great necessity and danger, and with buildings which were not fireproof, it was absolutely necessary to have appliances which could be easily and safely used, and that could not be done in any other way except by sprinklers. The New York Building Act provided that every theatre should be so fitted, and that supported his view to a considerable extent. He happened to be one of the judges at an exhibition of hand grenades, and his opinion of them was not very great. One of the members of the Metropolitan Board of Works was also one of the judges, and he thought he could demonstrate how a fire could be extinguished with these grenades, but he threw three, one after the other, neither of which burst, and the fire went on, but he was happy to say it burned itself out harmlessly. He would not trust a building of any description to these appliances. He drew attention to Mr. Farini's collapsing seats, entirely of iron, except the stuffing, which would not burn very quickly, and could not be a source of danger. One gentleman said you could not adopt the Asphaleian system in all theatres, and no one supposed they could, but they must begin to improve some time, and thinking this was an improvement, he suggested it as such. In building a new theatre improvements must be considered, and until some improvement were introduced they would go on having more accidents, and losing more lives, and would never attain safety in public buildings.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Emden, which was carried unanimously, and the meeting adjourned.

Mr. JAMES DOULTON writes:—In answer to Mr. Rodgers, I beg leave to say that, under ordinary circumstances, the superincumbent weight of the wall is sufficient to counteract the thrust of the arch in our system of flooring, but where it is required to sustain exceptional weight, no doubt the rod would be necessary at the end arch only, the same would also be necessary where there is no weight above, such as in its use as a roof. I may mention that in the case at Whiteley's, where we are supplying the floors anp roofs throughout, tie rods are used in the roof, and for the reasons already mentioned. In conclusion, I would add that in our system the whole of the iron work is protected, and that with a thoroughly fire-proof material, which Mr. Rodgers in his remarks deems to be the very best, namely, clay.

Mr. J. SHEPPARD writes:—The construction of an auditorium of a theatre with fire-resisting materials, with the object of preventing the fatal spread of smoke and flame, is, I fear, doomed to failure. The fate of the victims of the Exeter disaster was sealed before anything had taken fire in the auditorium beyond the upholstery and furniture. Whatever the general construction these are a necessity. It is important to keep in mind that the conditions surrounding a fire which may break out in the upper part of a theatre stage are totally different from those existing in other cases. Below the fire, and extending to the whole of the auditorium, there is a large space without any complete horizontal division, through which the air, being highly rarefied, exerts less pressure than that of the outside atmosphere, while above the fire there is a spaced wooden floor, with a large quantity of highly inflammable material, and a slight roof fitted with skylights and fixed ventilator, and probably windows in the upper part of the walls. By the time the fire has burnt large openings through the roof or windows, the air below the fire, being further exhausted, reaches its maximum difference of pressure. The outside air, rushing in to restore atmospheric balance, passes through the burning portion of the stage, and carries with it smoke and flame to every portion of the building. This sudden rush of air has a force sufficient to wreck any metal screen that could be used for the procenium opening. The iron curtain at the Berlin National Theatre, referred to in vol. xxxi., page 688, of the Society's *Journal*, was probably destroyed in this way. Definite evidence of the violent rush of air from the stage was shown at the Exeter and Islington theatre fires. To prevent this evil and its fatal consequences, it is necessary to construct the roof and upper part of the stage with fire-resisting materials, having sufficient strength in every part to resist considerable external pressure, the stage ventilator being of iron arranged to prevent the possibility of down draught. Air inlets should be provided at convenient points about the lower part of the building, fitted so as to open only in the event of undue difference of atmospheric pressure arising. This arrangement would preserve a safe atmosphere in the building for a considerable time, affording ample opportunity for all quietly to leave the auditorium, and at the same time tend to localise the fire, and allow of it being attacked, with every chance of saving much of the building. The above provision against any sudden rush of air from the stage, used in conjunction with a fire-resisting

curtain, would give the utmost amount of security. In addition to forming the gridiron, flies, fixed portion of stage and its supports, with fire-resisting materials, I would suggest that the proscenium border should be of brickwork, upon which any desired decoration could be placed. This, in many cases, would reduce the height of proscenium opening very considerably, and add much to the security of the audience. The numerous ropes used to support and work the scenery form one of the chief sources of danger about a stage, as these all pass over the gridiron and collect in large coils on the flies. These ropes should all be of wire, and worked with metal winches in place of the wood cleats now fixed to the fly rails for holding the ropes in any required position. The cloths could be attached to the wire ropes with slip links, which would admit of any cloth being cut down with greater ease and speed than at present. The security afforded by electric light is more apparent than real. In the present condition of electric light generation and distribution, it is impossible in theatres to rely solely on this mode of lighting, and it is necessary to have gas in constant readiness, with pilot lights burning. The occasional sudden use of gas is likely to lead to accidents, and this, in addition to the possible dangers with electric light—from a defective joint, a short circuit, overheat of resistance coils and transformers, the risk from dynamo and its motor, and other canses—leaves the risks from the illumination of a theatre much where it was before the introduction of electric light. Emergency lights should, as far as possible, be so arranged as not to be subject to the influence of internal conditions, otherwise these would be liable to be extinguished with the ordinary lights. All experience shows it to be of the utmost importance that all entrances and exits should be entirely independent of each other, and enclosed with fire-resisting materials; without doors of any kind, except one to the portion of the theatre they are intended to serve, and one to the open air.

Correspondence.

METHODS OF TAKING THE BALLOT.

In my endeavour to be terse in this matter on Wednesday last, I fear that I did not make myse'f sufficiently clear, and therefore I solicit a little space to make a few further remarks.

The State takes no trouble to inform electors individually that an election is about to take place, though the choice of a fit and proper person to represent the electorate in the Imperial House of Legis. lature is of much moment to both place and people.

To proclaim this, and to afford all the electors some nformation, would be the first act of the postal plan; the present system gives alone the bald surname and the prename of the candidate, and nothing more of his status or *locus standi* than may or may not be got by hearsay. To this I would add the profession and residential direction as some clue to the elector, who may not see the propriety of returning a specialist, land owner, manufacturer, or absentee.

All along its course the envelope system would leave a trail of evidence, in fact, from its first print to the final packing of the single-card vouchers, they would be as finger posts and milestones marking the whole route, and, moreover, tangible records that could be kept and consulted, though they never would or could be made to divulge the secret vote when once its author had polled it, all traces being lost.

This no automatic contrivance can effect, and moreover, immobile machines must be few and far between, and are apt to suffer, being only for temporary provisional use; costly installations that would probably require tons of metal discs to work them if all went well, and doubly disastrous if they did not.

Mysterious machinery can never be more than an aid. It cannot give information other than that of a simple numerator—a piece of clockwork that would have to be jealously watched and vigilantly warded.

Immobile stations would demand the elector's time to reach, which is his money; he would need to have faith in its efficiency and hidden machinery, voting in a cell being repulsive; and we will take it for granted that when once deposited the vote would not be withdrawn, though there seems to be nothing to prevent a voter from walking off with a vote, or the substituting another of the same weight and dimension, which, in the case of personation, might complicate the fraud.

The danger of voting *in camera* seems to me very great. "One man and one vote" may be well for the enlightened elector, but for the mischievous voter, I will not call him an elector, obscurity and isolation would be a great incentive to trick—unless a rigorous search be instituted outside against the introduction of objects to arrest working, such as pitch or other substances, or tools with which the *pseudo*-elector might split his votes, or so bend them that they would refuse to leave the slot—or being master of the situation, he might wish to remain inordinately long. Blind men and cripples have no special provision made for them.

I am persuaded that, if we are to have mechanical appliances as aids to the present system, they must be portable ones, in full view of the presiding officer, though the operations must be unseen to all save the voter, and that the checks be of paper or card, as in the contrivance of the Rev. J. F. Bateman.

That the elections of the future will be carried out by the post I feel sure; that is, when voting shall come to be considered an intellectual accomplishment and not a lottery for the ignorant.

JOHN LEIGHTON, F.S.A.

London, Jan. 25, 1888.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 1.—"The Sweating System, or the Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS. SIR DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 31.—"The Monumental Use of Bronze." By J. STARKIE GARDNER, F.G.S. E. J. POYNTER, R.A., will preside.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

Lecture I., Monday, January 30th.

PROFESSOR HERKOMER'S LECTURES.

A course of three lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R.A., on Thursday evenings, February 2nd, 9th, and 16th.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. Gordon Salamon, "Yeast, its Morphology and Culture." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. W. E. Bear, "Agricultural Competition."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Admiral R. C. Mayne, "Summary of Explorations in British North Borneo." 2. Mr. Maurice Portman, "Exploration and Survey of the Little Andamans."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The Ptolemies."

TUESDAY, JAN. 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. Starkie Gardner, F.G.S., "Monumental Use of Bronze."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. J. Romanes, "Before and After Darwin." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion on Sir Bradford Leslie's paper, "The Erection of the 'Jubilee' Bridge carrying the East Indian Railway over the River Hooghly, at Hooghly." 2. Mr. A. C. Hurtzig, "The Alexandra Dock, Hull."

WEDNESDAY, FEB. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. D. F. Schloss, "The Sweating System, or the Functions of the Middleman in Relation to Labour."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. H. J. Eilwes, "The Lepidoptera of Sikkim," with corrections, additions, and notes on seasonal and local distribution by Mr. O. H. O. Möller. 2. Paper by Messrs. Geo. C. Griffiths and William White.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7 p.m. 1. Adjourned Discussion on Mr. O. Imray's paper. 2. Adjourned discussion on Mr. E. Carpmael's paper. 3. Mr A. M. Clark, "The International Convention as it affects the Granting of Patents of Invention."

Obstetrical, 53, Berners-street, W. 8 p.m.

Civil and Mechanical Engineers, Town Hall, Westminster, S.W., 7 p.m. Mr. T. B. Lightfoot, "The Use of Ammonia as a Refrigerating Agent."

THURSDAY, FEB. 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Extra Lecture.) Prof. H. Herkomer, "Etching and Mezzotint Engraving." (Lecture I.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. F. Blandford, "Ferns of Simla." 2. Mr. H. J. Veitch, "Fertilisation of *Cattleya labiata*, var. *Mossiæ*." 3. Mr. J. S. Baly, "Descriptions Species of *Galerucinæ*."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Prof. A. W. Rücker, "The Range of Molecular Forces."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. R. H. Scott, "Atlantic and British Weather."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. G. G. Zerffi, "Nature and Art, or Reality and Ideality."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Professor E. M. Crookshank, "The History and present position of the Germ Theory of Disease."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Herkomer, "Art Education."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Annual General Meeting. 2. Discussion on Mr. J. Richard's paper, "Irrigating Machinery on the Pacific Coast." 3. Mr. W. Geipel, "The Position and Propects of Electricity as applied to Engineering." 4. Report of Research Committee on Friction; Experiments on the Friction of a Collar Bearing.

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, FEB. 3...United Service Inst., Whitehall-yard, 3 p.m. Admiral the Hon. E. R. Fremantle, "Speed as a Factor in Naval Warfare."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. F. Crisp, "Ancient Microscopes."

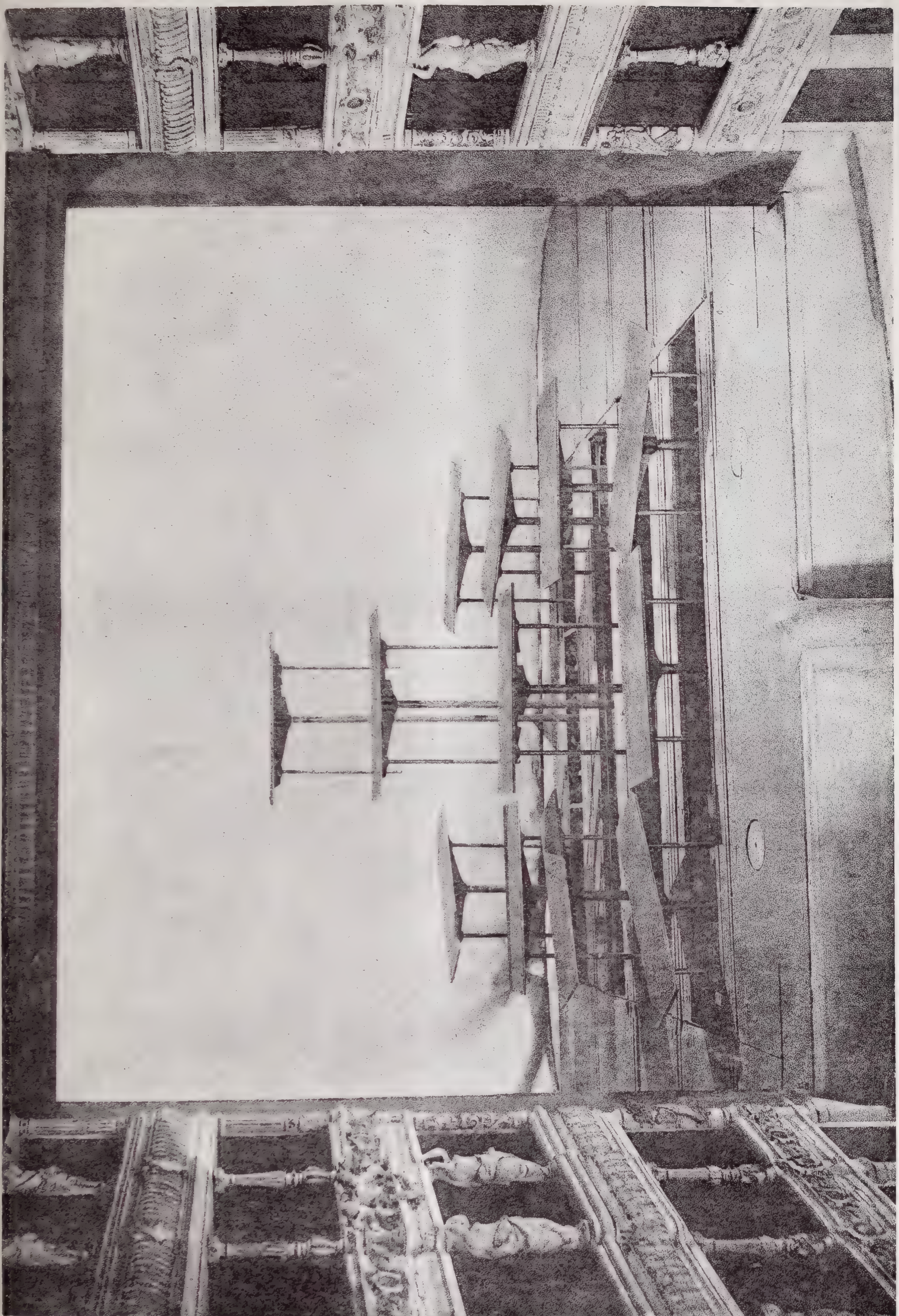
Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting.

Philological, University College, W.C., 8 p.m. Dr. R. Morris, "Pali Miscellanies."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Reading of Papers and Discussion continued.

SATURDAY, FEB. 4...Sanitary Assurance Association (at the HOUSE OF THE SOCIETY OF ARTS), 3½ p.m. Public Conference on the Sanitary Registration of Buildings Bill. Introductory address by Sir Joseph Fayrer. Papers by Mr. Mark Judge and Sir Vincent Kennett-Barrington.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture II.)



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Journal of the Society of Arts.

No. 1,837. Vol. XXXVI.

FRIDAY, FEBRUARY 3, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. A. Gordon Salamon, F.I.C., F.C.S., delivered the first lecture of the second course of Cantor lectures on Monday evening, January 30th, the subject being "Yeast, its Morphology and Culture." Mr. Salamon dealt with the position of the pure yeast cell among plants, and after describing the various fungi capable of inciting fermentation and putrefaction, pointed out the need of accurately defining the pure yeast species.

The lectures will be printed in the *Journal* during the summer recess.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Friday, January 27, 1888; Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Chairman of Council, in the chair.

The paper read was—

THE PUBLIC HEALTH IN INDIA.

By Mr. Justice Cunningham,

Of the High Court of Judicature, Bengal.

The layman who, with no pretence to scientific attainment, ventures to address the Society of Arts on any subject connected with "The Public Health" may excusably feel some qualms at his own temerity. Some of his hearers are past masters in the art of preventive medicine, and have for long stood protagonists in its beneficent struggles and victories. To their insight, their scientific grasp, their practical courage, their wise pertinacity in combating ignorance, prejudice, and indifference, are due, in no small degree, the benefits which the English nation now reap from improved sanitation. One would far rather listen and learn of such authorities, than discourse in their presence of topics with which they are completely familiar, and as to which they are the actual fountains of instruction. My apology to these gentlemen must be that the views propounded to-night will be but the echo of their own—the outcome of their own teaching; nor are they, in any sense, my personal opinion. I stand here as the representative of an association which has for some years past made the public health in India its especial care, which numbers in its ranks all the leading men of science in Calcutta—notably that accomplished physiologist, Dr. D. D. Cunningham; many high officials, amongst them, the Surgeon-General and Sanitary Commissioner of India; Dr. Payne, who, as Health Officer of Calcutta and Surgeon-General of Bengal, is perhaps better and more intimately acquainted with the history of the subject than any living person, and Dr. Harvey, who is not only a high official, but one of the first physicians in India.

The conclusions arrived at by such a body after several years' practical dealing with the subject are, I think you will admit, not likely to be rash, nor their recommendations unpractical. It will be their views that I shall submit to-night, and those of the Army Sanitary Commission; and as I shall refer to no statistics but those which are officially prepared, I venture to hope that—whatever be the shortcomings of the speaker—material may be afforded for a profitable discussion. I propose first to give a short sketch of the sanitary position in India, and what has been already achieved in the way of prevention of disease,

to examine how far it is possible, with the existing administrative machinery, to extend to the population of India the benefits which, during the last fifty years, sanitary improvements have achieved for the people of England. I shall then review certain administrative reforms which fall within practicable limits, and would facilitate that achievement. It is of no use to discuss Utopias, and sanitary Utopias are as bootless as political.

General Sanitary Condition of India.—The population of which health statistics are collected, and about which anything is known, is something under 200,000,000; it spreads over an area of 881,000 square miles, about as large as Europe without Russia, with local varieties of climate, rainfall, soil, national habits and character as pronounced as any that can be found among the various European States. These varieties range from the dense jungles of the Deltaic Bengal, with a heavy rainfall, moist, hot temperature, tropical exuberance of growth—the rich valley of the Ganges, and the wide stretches of agriculture of Upper Bengal, with their closely packed population—to the blazing plains of the Punjab, with fierce extremes of heat and cold, and high, barren uplands of Central Madras; from Cherapungi or the Western Ghats, with several hundred inches of rain in the year, to regions where the annual rainfall is an inch, or Scinde and Rajpootana, where there is no rain at all; from the quiet and polished Bengali to the wild hillmen of Chota Nagpore or the Punjab frontier; from regions of Eastern Bengal or the Malabar coast, where nature is one great exuberant garden, to regions where a precarious livelihood depends on a few showers or inundating floods, that as often as not never arrive. The varieties of condition in this great aggregate of humanity are infinite; but there is one terrible uniformity—in the maladies which beset it, in the epidemics which sweep like destroying angels across it, and which, in close-built city, teeming bazaar, in the myriad villages, or on desolate mountain side or forest clearing, make their terrible presence felt, and levy their tribute of death from all alike.

The Rural Population.—The population of India is for the most part scattered about in villages. The Indian village is almost invariably a collection of huts, closely huddled together for defence against invaders, marauders, or wild beasts. It is often surrounded by a mud wall, or built on some raised spot, which was once serviceable against assailants, and which now serves for refuge when some overflowing river has turned the country for many a mile around into an inland sea. It is designedly wretched-looking, for the object of the inhabitants was to expose as little as possible to attract the attention of freebooter, or what was often but another form of freebooter—the tax-gatherer. The village is a sturdy boat, sailing with canvass tight-furled on a sea of many storms, and it has survived them all. Most of the huts have stabling within, where the tethered bullocks may be seen munching at the chopped straw which, except when the rains bring a blessed banquet for a few months, is their constant fare. Bullocks and cows everywhere recall the epoch when the great Aryan family thought of daughters as the little milkmaids, or the early Roman days when *pecus* was synonymous with *pecunia*. From each hut trickles a little fetid stream, which disposes of itself as best it may, and has for centuries been turning the village soil into a mass of nitrates, and finding its way to the household well. Outside, the ground is trodden into an arid waste by the innumerable feet of passing herds—on one side is the village threshing floor, where four or five bullocks, revolving round a post, are treading out the corn—or, a little later, the grain is winnowed by the passing breeze. Inside you will hear the weary grind, where women are toiling at the mill. Outside there is a dismal spot, which none but the outcast will approach—the refuse heap, where lie the wasted treasure, skeletons of dead bullocks, bones and the like, which chemistry would turn to gold; a little farther is the village well, or, in other parts, the tank. As seen by the eyes of a Bombay civilian*, how romantic an object! the wide sheets of verdure that surround it—young wheat and grain, the orange and gold of mustard and safflower—the snow-sprinkled crop of cotton, or deep brown of the occasional fallow, the teal that dive among its waterlilies, the snipe that rise from its rushes, the paddy birds, peacocks, stately cranes with crimson heads that strut on its shores, the quails and partridges, and antelopes that haunt the surrounding crops—the village peeping through a palm-grove, the stately tamarind and sacred peepul—the long string of buffaloes wandering across the dusty plain, or wallowing in felicity in the mud, —the ceaseless groups of Hindu women coming to fill their pots or wash the household vestments on the steps, or pray for a husband's

* W. J. Pedder, "Asiatic Review," i., 377.

life or love at the little shrine of Gunpati among the babuls—the elders discoursing beneath the banyan tree, probably on the craze of the new magistrate, who explains the prevalence of fever in the village by its water-logged soil or foul tank.

Alas, that such a pretty picture should have another side, that such romantic accessories should have a dirty aspect; for the tank is too often mere sewage. Every shower washes surface filth into it; every dust storm carries some more; a perpetual series of bathers adds daily to its impurity; clothes and cooking utensils contribute their modicum of dirt; as the dry season lasts it grows lower and dirtier. In a city like Calcutta or its suburbs, the tank is a mere pool of fermenting sewage, the common cloaca of the neighbourhood, where the luckless denizens of the huts that crowd its banks may be seen bathing, washing their cooking pots and garments, and filling their drinking pots with a fetid liquid about the colour of London porter.

The Towns. — The collections of houses dignified by the name of towns have but few of the characteristics of order or beauty of the European city. With the exception of Calcutta and Bombay, and few more, they are but aggregates of houses, crowded pell-mell into narrow lanes, with cesspools under them which receive the sewage, and wells which are largely indebted to the cesspools. The European officials insist, perhaps, on a little surface cleaning in the main thoroughfares, but even here the open drain which runs along each side of the street shows a black stream which emits a pungent aroma, and if you inquire what becomes of it, you will find that it either goes into a neighbouring river, or is left to stagnate in some ditch. One such ditch, the Mahratta Ditch of history, has for long surrounded Calcutta. A long straggling bazaar exhibits, on the vendors' stalls, close upon the drain, the provisions of the inhabitants. Upon this state of things imagine several months of absolute aridity and tremendous heat, and several weeks of tremendous rainfall, and, in Upper India, several weeks of excessive cold. Add to this that most of the people are extremely poor, lead the hardest lives, sleep in huts built on an undrained and much contaminated soil, and often live on fare that a London beggar would turn up his nose at. The sanitarian knows what to expect. Here, he says, there will be an excessive mortality and a fine field for epidemic disease.

General Sanitary Condition. — Nor will his gloomy expectations be disappointed. I will, if I may, take a single year, 1885, the last of which we have complete official record, with the comments of the Army Sanitary Commission upon it.

Coming to figures, I must premise that those which I employ are in a high degree untrustworthy. Vital registration has been in force some years, but the mechanism is of the rudest, and the results show by their variations how little they are deserving of implicit confidence. Thus we have a registered birth-rate which varies from 45 per mille in the Central Provinces, 43 in Berar, and 41 in the North-West Provinces, to 25 in Bengal and Burmah. One district in the North-West Provinces showed a birth-rate of 53, while a district in Bengal showed one of 7. There were, in 1885, 5,000,000 of deaths registered in British India, giving a ratio of 26 per mille. But this result was derived from wide variations, from 16 per mille in some provinces, to 34 in others.

DEATH-RATE PER MILLE IN 1885.

Mysore	15·91
Burmah	19·98
Madras	21·8
Bengal	22·74
North-West Provinces and Oudh	31·98
Central Provinces	34·21
Bombay	28·78

The highest of these rates was largely exceeded in some considerable areas:—Fifty per mille was registered for an entire District in the North-West Provinces, and 56 per mille from one in the Central Provinces, while some towns had a registered mortality nearly twice the highest of these figures. On the whole, all we can say of the figures is that it is improbable in any case that they overstate the mortality, and certain in many others that they grossly understate it, especially in Bengal, Madras, Burmah, and Mysore; here probably the true mortality is nearly double that shown. The real death roll of India is probably nearer 7,000,000 or 8,000,000 than 5,000,000. Let us examine the composition of this death-roll.

TOTAL DEATHS IN 1885.

Cholera	385,928
Small-pox	80,630
Fevers	3,396,239
Bowel complaints	293,638
Injuries	83,262
Other causes	937,903
	5,177,600

On this mortality the Army Sanitary Commission, which has watched the course of events for the last twenty-seven years, make two very important observations. After analysing its causes, they say in the first place—"We learn from this Table that above 78 per cent. of the entire registered mortality was due to mitigable or preventible diseases," and in the next place, reviewing the figures since 1876, they observe that, setting aside the abnormal effects of the great famine of that and the following year, the deaths from cholera "show a tendency to increase. The small-pox mortality presents the usual epidemic character, and so does that of cholera, with a marked tendency to augmentation. The enormous fever mortality is also apparently increasing. All the diseases classed under this head are manifestly largely on the increase. We have called attention year after year to these facts." They go on to point out that there have perished in India within this decade* 38,000,000 persons from these epidemic diseases; they call attention to the fact that each of these deaths represents several cases of illness, amounting, in the case of fever, to attacks several times over the entire population, and to the frightful waste and national poverty resulting from this mortality and disease. "The record," they add, "altogether is a deplorable one, in face of the fact that all the diseases in the Table belong to the well-known mitigable or preventible class, towards the extirpation of which every civilised country has been labouring in past times, with the result that whole regions of the earth which were formerly devastated by fever pestilences and dysenteries have long since been free from them, except in the milder forms in which they now occasion part of the ordinary mortality."

Cholera.—Now let us examine the cholera mortality a little closer. The special home of cholera is a region of which Calcutta may roughly be described as the centre. In 1885 the disease extended in an epidemic form, for a couple of hundred miles on either side of Calcutta, northwards as far as the Himalayas; and to the south it was intense in Orissa, the sacred city of Puri attaining the phenomenal annual ratio of cholera mortality of 28·76 in the thousand. Other cities in Bengal reached ratios of 18 and 19·61 per mille. The Suburbs of Calcutta, a filthy region which has long been the opprobrium of the Bengal Government, attained a ratio of 7·4 per mille; several entire Divisions, areas with a population of a million or more, showed rates in excess of three per mille, Orissa heading the list with a ratio of 5·14. The total registered cholera mortality for Bengal, in 1885, was 173,767, equivalent to an annual ratio of 2·62 per mille of the population. No single town in Bengal, except the sanitarium of Darjeeling, escaped, and the mortality of several towns from this one cause alone was equal to, or greater, than the mortality of many English cities from all causes combined.

Jamalpore	19·61
Loori	17·41
Sitamurki	27·91
Poori	28·76

As we quit the endemic area the intensity of the disease diminishes. The North-Western Provinces added 63,000 to the registered cholera deaths, the annual ratio being 1·44 per mille; Madras contributed 58,000 deaths, yielding the annual ratio of 2 per mille; Bombay, with 37,000 deaths, showed a ratio of 2·27, one entire district reaching the high ratio of 10·63 per mille; the Central Provinces registered 21,800 deaths, a ratio of 2·48 per mille, and a maximum district ratio of 7·5 per mille. The disease, according to its usual habit, died away as the deserts of Rajpootana, Sunde, and the Punjab frontier are approached; here the mortality was insignificant; a small area only about the mouth of the Indus was affected.

It is true that the cholera mortality of India is but a drop in the ocean. Still the fact that no less than 386,000 deaths from this cause were registered in India as having occurred from this disease in 1885 is not one which the rest of the world can reasonably disregard. The disease has been present, Dr. Netten Radcliffe says, in an epidemic form for thirteen out of the last twenty years in Europe. The experience of the great epidemics of 1829-37, 1847-51, 1852-55, 1865, 1884-85, has shown with what fatal effect cholera may rage in Europe, when once it has established a footing in a congenial home. On grounds of the public safety of the world, no less than in its capacity of benevolent administrator, the Indian Government is bound, now that the means for obliterating cholera are perfectly understood,

* Deaths, 1876-85.

Cholera	3,250,000
Small-pox	1,750,000
Fevers	30,000,000
Bowel complaints	3,000,000
Total	38,000,000

to provide that neither the shortcomings of its own officials, nor the ignorance and short-sightedness of the public bodies which it has called into existence and invested with such important powers, shall be allowed to convert large areas in India into a nursing ground for the propagation of the disease and its dissemination to other parts of the world.

I am aware that when I use the word "dissemination" I tread on controverted ground, and that a late Surgeon-General of India has contended with great vehemence against the view that cholera is an "entity" capable of dissemination by human agency, or that India can be regarded as the fountain head of such dissemination. This is not of course a view that commends itself to the scientific mind, or which is admitted by men of science.

It is now generally felt that Dr. Koch's theory of the comma bacillus was stated too roundly by its originator, and rejected too summarily by his critics. Subsequent experiment in India, though it has failed to substantiate a causative relation between the comma bacillus and cholera, has established the remarkable persistency of the presence of the bacillus in such cases, and of its extreme rarity elsewhere. Whatever be the connection of cholera with those minute organisms which are the origin of so many diseases, it is certainly the opinion of the highest scientific authorities that the comma bacillus is an invariable concomitant, and that epidemics of cholera are propagated by the same natural causes, and obey the same laws of growth as govern other epidemics. This being so, it is on every ground desirable to trample out the disease in its favourite habitat, and this, there is good ground for believing, is possible.

Cholera has been described as capricious in its movements, which is, of course, only a way of saying that we are ignorant of the conditions which govern them. It travels in a set direction, generally to the west; it has, as we know, crossed the Atlantic; it has its chosen seasons; in Prussia, as Pettenkofer pointed out, a rise from a minimum in March and April, a gradual rise to July, and a rapid jump to a maximum in September. In India, in the epidemic area, it has two periods of outburst, a winter season, November to January, a spring season, March to May. In these two 83 per cent. of the mortality occurs. In Upper Bengal the winter mortality disappears, and the majority of deaths occur in the monsoon. In the east part of the North-West Provinces, the spring mortality is more serious; in the western parts, the majority is in August, September, and October. In the East Punjab maximum in May, in the West Punjab in August. The same seasonal differences occur in the rest of India. Are these differences dependant on subsoil level, a particular condition of soil, or what? Why are some places exempt and others always victimised? Why, in the severest visitations, do only a few localities out of many similarly situated, suffer, and a few individuals? Why does Bengal have 40,000 victims one year and 196,000 another? Why, in other parts of India, is the disease extinct one year, while sweeping away tens of thousands of victims the next? To such questions science, as in the case of other epidemics, has as yet no answer to give. The laws which govern them are unknown; but what is known is, that cholera is a crop which requires its seed-bed to be carefully prepared and the conditions to be congenial, and those conditions are dirt in air, water, and food, acting on enfeebled constitutions. Directly a locality or body of persons is removed from these conditions, cholera disappears from their midst. The illustrations have been frequent in Indian history, and they amount to demonstration. I will deal with them directly.

Fever.—Cholera, however, as a destructive agent, is local and temporary; the great universal and constant destroyer is fever. To this nearly 3½ millions of deaths were credited by the registering authorities in 1885. Of these deaths, the Province of Bengal contributed one million, showing an annual ratio of 15 per mille; the North-Western Provinces, 1,124,000, giving a ratio of 25·4; the Bengal showed a ratio of 18·4; the Central Provinces, 19·35; Bombay, 14·1; and Madras, 7·7; a ratio which it must be feared points rather to defective registration than to as high a degree of immunity as the figures would indicate. These imperfections of registration, and the habit of attributing to fever every death, not otherwise explained, render all generalisation dangerous, but there is reason to suppose that the ravages of the disease are intensified by the bitter cold of Upper India, and that the inhabitants of Bengal and Southern India, highly unfavourable as are many of their surroundings, benefit largely, so far as fever is concerned, from the comparatively equable character of the climate, and their exemption from the intense frosts of the North-Western Provinces and Punjab. The rates in some parts of Northern India are terrible. The Delhi district, for instance, showed in

1885, an annual death-rate from fever of 36 in the thousand, and some of the villages about the Western Jumna Canal rates of 35 and 42 per mille. It is, I fear, impossible to acquit several of the great Indian canals of having—certainly at some, if not all, stages of their history—tended to increase the liability of the population to fever, and the deadliness of that disease.

SMALL-POX DEATHS.

1883	232,300
1884	332,900
1885	280,630

Small-pox has cost more than 1½ million of lives in the decade, 1876-85, and more than a quarter of a million in 1883 and 1884; it is at present in one of its quiescent periods. As more than 4½ millions of persons were vaccinated during the year 1885, part of this reduction is no doubt due to vaccination, but the figures since 1876 point to the present as being one of the low periods, and scarcely justify the hope that any permanent reduction of the mortality has been effected. The figures for 1880, 1881, and 1882 were below those of 1885, but were followed by two years of great intensity. A certain amount of protection is no doubt afforded, and some municipalities are in favour of compulsory vaccination.

Contagious Diseases.—Time forbids me to deal with the other main causes of mortality, but there is one other class of diseases which no review of the sanitary condition of India could properly omit, the class technically known as "contagious." 14,000 sufferers were treated for various forms of this disease in the Public Medical Institution of Calcutta in 1885, and 4,000 of these were of a form that becomes constitutional and hereditary. In 255 instances the fact of a hereditary origin in that year was actually recorded. More than one-third of the European force suffered from it in the course of the year.

EUROPEAN ARMY.—ADMISSION RATIO PER MILLE.—1885.

All armies	343
Bengal	363
Madras	350
Bombay	270

As this alarming ratio has steadily increased from 1870-9, when it was 203 per mille, as 8,600 of the military cases were of that formidable kind which, as it is recorded, that in fully two-thirds of the cases the man who suffers from it is invalided within five years,* the subject is one which, however distasteful, we cannot, as men of sense and humanity, shut our eyes to. There is no question that the disease prevails to an alarming extent, and shows a formidable tendency to increase in the European army. This tendency is traced by the authorities to the increased youthfulness of the army, the decreased proportion of married men, and its more frequent movements. Apart, however, from these causes, there is good reason to fear that the disease is gaining ground in the country, assuming yearly more alarming proportions, and a more intense character. One reason alleged for this is the deteriorated condition of the class of women in India; another that the men come out from England in a more diseased condition.

"There is a gradually increasing belief," writes the Surgeon-General† of her Majesty's forces, Bombay, "that the number of men sent out from this country every trooping season suffering from disease introduce a more virulent form of disease among the native prostitutes, and serves to produce a more intractable form of disease amongst the soldiers of this country. This has been observed to be more especially the case at rest camps along the lines of rail by which troops are sent, and was especially noted when troops were sent up the Rajpootana-Malwa Railway to the North-West Provinces. If venereal disease is to have new life given to it annually—this more potent virus being introduced from England—then the matter deserves the earnest consideration of the military authorities both in England and at home. Moreover, numbers of soldiers ars shipped annually from England to India suffering from venereal diseases, and many have their constitutions so undermined that they are, to all intents and purposes, physically unfit to enter upon a tour of Indian service. This is a question of grave importance to the State, for not only is a great loss incurred by the State in transport charges and invaliding before a man's tour of service is completed, but inefficiency of the army must be the infallible result. That this increased prevalence of venereal disease among soldiers sent to India is due in a great measure to the suspension of

* Dr. Duncan McPherson, Inspector-General of Hospitals. See note by Surgeon-Major A. Barclay in the Sanitary Commissioners' Report for 1885, p. 105.

† "Medical History," 1885, p. 29.

the Contagious Diseases Act in garrison towns cannot be doubted."

We have in India some remarkable experience on the subject of the degree to which this disease is amenable to control, and may be got rid of by effectual supervision. Supervision was at one time exercised in Calcutta, and is now partially exercised in the army. I tread on controverted ground, but I have with me the strong opinion of the medical authorities in India, and of the highest military authority, when I say that the abandonment of the control once exercised with the most beneficial results in Calcutta, has proved as great a misfortune to the civil and military population as the opponents of that abandonment predicted, and that the result of the experimental abandonment, in certain garrisons, in 1884-5, has been to show conclusively that the general abandonment throughout the garrisons of India would be a calamity and danger of the first order. The result, as recorded officially, was, that, while the year was everywhere one of increase, the increase in those cantonments where it was experimentally abandoned was 130 per mille more than in those in which it was maintained Applying this ratio to the whole European garrison, Surgeon-Major Barclay reckons that the general abandonment of the control would have cost the Government 7,451 admissions, or, at 20 days per man, 149,000 days of inefficiency.

In Calcutta, unhappily, the control was abandoned—not tentatively, but finally. The effect of the Act, as officially reported (1877) had been, that the per-centage of men in the Calcutta garrison attacked with serious forms of the disease was reduced from 9 per cent. in 1868, to 1·4 and 1·3 per cent. in 1878 and 1879, that the ratio of diseased persons among those under control was 1·7 per cent., as against 29 per cent. among those for the first time supervised. In 1881, the working of the system was again officially considered, and with the same result. "The worst forms of the disease had practically disappeared." However, the Act was suspended, and in 1884 the medical officer, who knew the subject, reported that while there could be no second opinion that the Act worked with most excellent effect on the health of the town and the soldiers, the withdrawal of it had, in the course of nine months, undone all the good that has been effected. His words were confirmed by the fact that in 1884 the ratio of all admissions rose from 7.4 per cent. in 1873, to 58·14 per cent. in 1884, and of admissions of the graver class of disease from 1·4 per cent. in 1874 to 30·24 per cent. in 1884.

I will not continue the subject further, but I would earnestly commend to the notice of those who urge on the Government of India the abolition of control, the memorandum of Surgeon-Major Barclay, contained in the Sanitary Commissioners' Report for 1885, and the letter of the Health Society on the subject. Here, we say, is a case of a disease, which had been practically extirpated, deliberately revived, in obedience, not to any local complaint—for I believe none such was made—but to the sentiment of a certain class of agitators, male and female, in England. I desire to speak of these persons with all courtesy, but I should be concealing the truth if I did not record my solemn protest—a protest in which I know I am supported by the Head of the Indian Army, and the vast majority of medical officers in India—against the cruelty and folly of this intentional and deliberate abandonment in India of the known means of suppression of a terrible hereditary disease.

Effect of Sanitary Reform in England.—We have now reviewed the general sanitary position, and have seen the ravages of the principal diseases, a population defenceless against epidemics, millions of them carried off yearly by great epidemics, tens of millions undergoing yearly the suffering of disease. One's conscience becomes more acute when we consider what we are doing for ourselves. We have reduced our national death-rate from rates as high as those now prevailing in India to one of 19 per mille; we have reduced the death-rate of London, once 50 per mille, to the same. We have reduced the ratio of many localities much lower. The great epidemics have disappeared. Coming to recent years, we have reduced our small-pox death-rate from 57 in the 100,000, in 1838-42, to 6·5, notwithstanding one imported inroad of great malignancy in 1870-1, thereby causing an annual saving of 12,000 lives. The typhoid death-rate, since 1869, has sunk from 3·9 to 1·7 per 10,000, a saving of 5,000 lives per annum. Typhus mortality has sunk from 1·9 per 10,000, to 0·1 per 10,000. Every year shows us fresh fields in which science may counteract the lethal agencies by which man is surrounded. The general result was recently summed up by the President of the Association of Public Sanitary Inspectors in the fact that, at the end of 1887, 84,000 people were alive who would, in 1837, have died in the course of the year; that 1,750,000 of people enjoyed

immunity from disease who would have been seriously ill; and that all round, every Englishman enjoyed $3\frac{1}{2}$ more years of life. All this has cost, and continues to cost a great deal; a sum of £140,000,000 has been borrowed—a yearly expenditure of £8,000,000 is incurred—but does anyone grudge the outlay on economical or humanitarian grounds? Englishmen like to see the worth of their money, but does anybody doubt that here they see it in the prevention of loss, of suffering, of bereavement, of the needless curtailment of lives on which others depend for sustenance or for happiness. Dr. Farr reckoned that every Englishman's life was worth £150; but without going into that calculation, no one can doubt that a great mass of impoverishment and destitution is due to the premature deaths or incapacity of those who were otherwise qualified to act as breadwinner for a family. Look at what disease costs the nation in earnings—computed by Sir James Paget at $11\frac{1}{2}$ millions per annum for the working classes alone—and who can doubt that its costliness is such that any curtailment of its ravages is well worth purchasing.

Can a similar improvement be effected in India.—The question next arises whether an analogous improvement is attainable in India, or whether the ravages of epidemics in that country are due to inherent climatic causes over which we have no control, and against which, accordingly, it is useless to contend.

Effect of Sanitary Reform in the Army of India.—On this point we have the advantage of several instances of the utmost value. The British army of 50,000 to 60,000, and the native of 100,000, and the jails with a population of 80,000 and 100,000, have for years past been under close observation. When, after the Crimean War, the sense of the importance of the subject from a military point of view had been forcibly brought home to men's minds, a Royal Commission was appointed to inquire into the condition of the European force in India. It was at this time deplorable.

The average ratio of annual mortality of European troops in India had, for some years previous to the submission of the report, ranged as high as 69 per mille; at some unhealthy stations the ratio was 115 per mille. This death-rate the Commission stigmatised as unnecessary and wasteful. They pointed out that, assuming a death ratio of 20 per mille to be (as they contended it was) attainable by the introduction of proper sanitary measures, the needless loss, occasioned by bad sanitation, involved the necessity of recruiting 3,570 fresh men annually, and that, estimating the annual cost of each man at £100, the charge thus thrown on the Government was £357,000, or nearly £1,000 per diem. Putting the case in another way, they showed that, of the 70,000 European troops in Indian garrisons, 5,880 were always in the hospitals, where 4,830 died every year; in other words, that the ratio of daily sick was 84 per mille, and the death-rate 69 per mille. At the prevailing ratio it was shown that an entire European army disappeared in $13\frac{1}{2}$ years. Apart from the considerations of humanity and economy, there was a grave administrative motive for remedying this state of things. For Sir A. Tulloch reported that, with the rates which had prevailed in the preceding 40 years, it would be practically impossible to keep up an army of 70,000 Europeans in India, as sufficient recruits could not be obtained to fill up the gaps occasioned by death and invaliding.

The Commission recorded the opinion, not only that the death ratio might by proper sanitary measures be reduced to 20 per mille, but that, if the general conditions of the health of the population were improved, as by large measures of drainage and other like works, we might hope to see the death-rate of the European army sink to as low a figure as 10 per mille.

These anticipations have been to a large extent realised. The annual death ratio for the European army in India for the last four years has ranged between 12 and $14\frac{1}{2}$ per mille. In 1885 the ratio was 14·5 per mille, the invaliding ratio was 23 per mille, so that the ratio of loss from both causes—37 per mille—was little more than half the death ratio of the earlier period. If we compare these ratios with those of the decade 1870-79, a substantial improvement is observable:—

	1870-79.		1885.
Death-rate per mille..	19·34	..	14·55
Invaliding ,, ..	43·0	..	23·0
	62·34	..	37·55

As regards some particular diseases the improvement has been signal. Take, for instance, cholera in the Bengal army, which garrisons the whole of Upper India:—

Cholera Death-rate per 1,000.

	Bengal Army.
1860-69	9·24
1870-79	4·18

1880	4·84
1881	3·23
1882	1·28
1883	0·94
1884	1·34
1885	1·17

or, taking the death-rate by districts,

Cholera Death-rate per Mille.

	1870-79.	1885.
Lower Bengal	6·26	2·85
Gangetic Provinces	8·12	1·74
Meerut	6·35	0·70
Agra and Central India	15·94	1·90
Punjab	8·89	0·77

In the Madras Army the cholera death-rate has fallen from 1·68 in 1870-79, to 0·19 in 1885, and in the Bombay Army, excluding Quetta, to a still lower ratio.

Let us next take the jails, and let us compare cases where all the conditions except sanitation are in a high degree similar.

When Sir John Strachey wrote his Report,* the mortality for 1861 in Indian jails had been as follows:—

	Cholera deaths per mille of average strength.	Fever deaths per mille of average strength.	Total deaths per mille of average strength.
Bengal Proper and Assam	13·2	—	81·7
Behar	11·	—	76·1
Nagpore	2·	—	34·
Rohilkund and Agra	44·	51·9	183·7
Panjab	4·	29·2	81·6
Bengal Presidency	15·2	16·1	96.7

In Agra jail during March, April, and May, out of 2,400 prisoners, 1,340 were attacked with cholera, and 260 died.

In 1885 the rates were as follows:—

	Cholera Deaths.	Dysentery and Diarrhea.	All Causes.
	per mille	per mille	per mille
Bengal	4·07	14·68	38·40
Madras	0·43	3·89	17·86
Bombay	2·62	5·68	33·76

* "Sanitary Commissioner's Report, 1865," p. 79.

The highest of these rates is scarcely more than a third of the former ratio, but look at the lowest. The mortality in the Madras jails in 1885 was 17·86 per mille, against 33·76 in Bombay, and 38·40 in Bengal. To contrast particular instances, the population of Salem jail, 397 in number, showed a death-rate of 2·52 per mille, whilst six jails in Bengal gave rates over 100, three of them giving ratios in excess of 150. Whatever allowance be made for particular circumstances explaining this discrepancy, it is impossible to doubt, on these figures, that powerful insanitary influences existed in the one case that had been removed or mitigated in the other; and the experience of Madras shows that when health is duly considered, the inhabitants of India—even the jail portion of it, with all the drawbacks incidental to confinement, new employment, &c.—do not point at a higher rate than ordinary healthy European populations.

Now, with these facts of the army, the jails, and Calcutta before us, it is impossible to doubt the conclusion that a very large proportion of the mortality of India, is, in the strictest sense, preventible; in other words, that it arises from certain ascertained conditions, which it is within the practical competence of the community to alleviate, if not altogether remove.

This brings us to the question of what is being done. We need not go back earlier than the Royal Commission of 1859. That body gave a most serious account of the general sanitary condition of the country. They reported that "the towns and bazaars in the vicinity of lines are in the worst possible sanitary state—undrained, unpaved, badly cleansed, often teeming with offensive and dangerous nuisances, with tanks, pools, and badly made surface gutters containing filth and foul water; the area over-crowded with houses, put up without order or regularity, the external ventilation obstructed, and the houses over-crowded with people; no public latrines, and every spare plot of ground covered with filth in consequence; no water-supply except what is obtained from bad shallow wells, and unwholesome and doubtful tanks. These towns and bazaars are the earliest seats of epidemics, before their ravages extend to the European troops in the vicinity. . . . The arrangements for the prevention of disease are either non-existent or most deficient. There are no proper sanitary authorities in towns, no trained officers of health in any town or cantonment, and no means whereby the experience obtained

in dealing with sanitary questions at home can be rendered available for India."

This state of things the Royal Commission proposed to remedy by the creation in each presidency of a Commission of Public Health, so constituted as to represent the various elements—civil, military, engineering, sanitary and medical; charged with the executive superintendence of all matters pertaining to the sanitary improvement and the prevention of epidemics, and with the oversight of the general condition of the population, and with the duty of reporting on the prevalence of disease and the means of preventing it. On this the Government took action, and a Commission was created, one of the prominent figures in which was the present Sir John Strachey, whose administrative ability made him as prominent in this department as he has since been in others, and justified the doctrine familiar to the students of the etiology of Indian improvement, that wherever an outbreak of energy has occurred, or an epidemic of good sense prevailed, the *bacillus Strachiensis* is an invariable concomitant. However, the provincial commissions as recommended by the Royal Commissioners were not ultimately carried out in their integrity, and the result has been that, while there is a fairly satisfactory machinery of sanitary inspection and reporting, the executive superintendence, the process of actual guiding and controlling the work of sanitation is performed, so far as it can be said to be performed at all, by the Government.

In the meanwhile the task of sanitation has been entrusted to various local bodies in the towns to municipalities. In 1885 there were 749 of them, with a population of 14,500,000, and an income of about 2,500,000. Among these municipalities those of the two great cities of Calcutta and Bombay play an overweening part, the income of the 130 municipalities in Bengal, with 2½ millions population, and of 160 municipalities in Bombay, being respectively about the same as that of the capital cities.

	Incomes in 1885.
Bengal:—	£
133 Municipalities	263,000
1 Calcutta	277,000
Bombay:—	
160 Municipalities	433,000
1 Bombay	438,000

These figures indicate to how large an extent municipal expenditure is confined to these two great centres, and how extremely little is, or can be, effected in other towns. But the inhabitants of municipalities are but an insignificant fraction of the general population, 200 millions, and here the sanitary agency is still more completely defective. The Government of India has for a long period followed the policy of enlisting the general population in the various functions of self-government; and in 1883, and the following years, a strenuous effort was made in this direction in all the chief provinces of India to render municipalities more independent of official control, and therefore more interesting and attractive spheres of action, and to create in the rural districts bodies of residents for the management of local interests, sanitation among the rest. The general outcome of this movement has been the creation, throughout the rural districts, of small local Boards, grouped around a more important central Board, and so far elective in their constitution as to impress the members with a sense of independence, and so of responsibility, retaining only such an official element as may serve to represent the views of authority without swamping independent opinion. Sufficient time has not elapsed to justify any conclusion as to the success of this experiment, and men's views about it and the probability of success will differ according to their temperament and experience, and the side of the question with which they have especially had to deal. It is difficult on the one hand to magnify the importance of the benefits which would accrue to the Indian community, if the leading inhabitants of the country could be induced to devote time and trouble to an intelligent and disinterested concern in local interests—such as, for instance, may be found in England. And it is not probable that any administrative machinery that the rulers of the country can devise will meet the requirements of the case in the absence of this important assistance. On the other hand, those who most cordially wish success to the scheme cannot shut their eyes to the difficulties which confront it in India—the non-existence of any leisured class of the intelligence, activity, independence, and business habits which is essential to the proper working of local self-government; the traditional reluctance of the upper classes for works of the kind; the danger of the ascendancy being gained by some active spirits, with little guarantee for due consideration of the rest; the bitter class and race feelings which are always smouldering when different races and

religions live side by side ; the absence of a healthy, strong, public opinion, keeping men straight in public action ; and the general and excusable ignorance of the real importance of such subjects as sanitation, of their worth to the community, of the measures necessary to secure the end in view, and the risk, the almost certainty, that the machine, thus embarrassed, will not work satisfactorily, but sooner or later will come to a deadlock. It would be ungracious and wrong to disparage the attempt, or to damp the hopes which have prompted it. The Hindus are a most intelligent race, of quick receptivity, and agile in adopting themselves to new conditions. But the main originator of the new *régime* himself expressed some misgivings as to the sacrifices in the line of efficiency it might entail, and prepared us to have to deal with such sacrifices as the price at which habits of independance and self-government must be purchased. Those misgivings are certainly very present to the minds of those who are impressed by the almost incalculable evils which the insanitary condition of the people of India bring upon them, and who know by practical experience, by years of weary and bootless effort, how difficult it is to bring home to the minds of even a comparatively educated community the necessity of the sacrifices necessary to purchase the benefits of improved public health, and especially to protect themselves against the invasion of the great epidemics which now devastate the country. Judged by our own public bodies in this country—we remember what they were thirty or forty years ago—we know what public bodies can be even now in the full blaze of light that has been thrown on the subject, and the general feeling of Society about it. Was not the parish vestry the very type of everything that was obstinate, retrograde, selfish, unenlightened, and do we not hear complaints even now that indicate that this type is not extinct. Are all public bodies in England enlightened and conscientious ? Well, does any one expect you can get in India, or will be able for the next half century to get, bodies of men throughout the length and breadth of rural India anything better or as good as we get in England. Is there not grave danger that the noisiest, the most self-seeking, possibly the most corrupt, the most vindictive champion of clique, or religion, or nationality, will come to the front ? that time and labour will be fruitlessly spent ? that quiet people who would welcome reform will be silenced ? that any grievance will be deemed less than the encounter of hostile factions ? and that meanwhile no progress will be made in those solid and sensible reforms on which the real prosperity and well-being of the community depend ? If you tell a child to run alone, to act for itself, to think for itself, when it can neither stand, or think, or act, and the natural results ensue, do you escape your responsibility ? Am I drawing an imaginary picture ? Let us take a single instance, a semi-rural tract which surrounds Calcutta on three sides, and is known as the suburbs. It has an area of 22 miles, and a population of 250,000. Now I will ask you to consider the mortality of some of the wards :—

Ward.	Death-rate per mille from all causes.	Cholera Death-rate.	Fever Death-rate.	Bowel Complaint Death-rate.
Cossipore ..	67·16	14·48	21·09	10·14
Ooltadunga. .	70·07	19·55	19·18	11·03
Maneklotter .	57·53	11·52	19·31	19·30

There are several other wards with death-rates between 40 and 48, and the result for the whole municipality is a death-rate of 45½ per mille. Those who hear me know well the significance of these figures—what a death-rate of 70 in the thousand, of which 50 are contributed by cholera, fever, and bowel complaint. Even this is an improvement on former years, in one of which the mortality for the entire municipality was 69·4 per mille. During the ten years, 1876-1884, out of a population of 250,000 no less than 127,000—more than half—perished, and one ward lost two-thirds of its inhabitants in eight years. Nothing but continuous immigration saves the population from becoming extinct.

Sir John Strachey, in his Report in 1864, declared that the condition of Calcutta was a scandal and a disgrace to a civilised Government. It is melancholy, after the lapse of nearly a quarter of a century, to have to admit that many parts of Calcutta, and all the suburbs, still merit that denunciation.

Now this is a municipality conterminous with the capital throughout, parts of which lie within a few yards of the cathedral, the General Hospital, the race course, the university; many of the residents are educated native gentlemen; it has also the advantages

of the neighbourhood of the city municipality, and the benefit of their experience; the striking illustration of the effects of sanitation in reducing its death-rate, in 1885, 29·3, against the suburban ratio of 44·8. And yet the result has been what we see. Speaking of Bengal in 1885-6, the Blue-book says, "The elected commissioners are reported to have taken much interest in the affairs of their respective municipalities. The elective system has undoubtedly proved a success." How easily such phrases run off the clerkly pen; but how badly they harmonise with figures such as those given above, or with the filthy condition in which, under the very nose of all the collective authorities of the Governments of India and Bengal—the Lieut.-Governor resides in one of them, and the Governor-General drives through another every time he goes to Barrackpore—this unfortunate population has been allowed to continue. If this is the state of things around Calcutta, what are you to expect in remote municipalities where the pulse of officialdom beats more weakly, and supervision is necessarily less complete.

Municipalities in the North-West Provinces.—Let us take as another instance some municipalities at the other end of Bengal, the North-West Provinces. "Speaking generally," say the Army Sanitary Commission, "the town death-rates were excessive, in many cases exceeding 20, 30, and 40 per mille. As examples of extreme rates we may cite the following towns, all of which are under some form of municipal government, and are supposed to be entrusted with power to protect the health of their people."

	Deaths per mille.
Sahtawar	41·18
Kamigung	48·74
Manipoor	48·77
Aligarh	52·86
Balaashapoor	54·30
Adjudhia	70·77
Sikundarabad	74·09
Khunjab	84·81

"In most of the towns the evidence seems to be conclusive that the local authorities are either in total ignorance of the measures requisite for preserving health, or that they have neither means nor power to apply them."

Supervision urgently needful.—Now, there is no reason to suppose that the municipal bodies in other provinces are superior to those of the North-West Provinces and Bengal, or that these are unfair samples of what may occur elsewhere. Are our apprehensions vain, when we see the enormous work that has to be done, and the frail instrumentality provided for doing it? and are we asking anything irrational when we urge that this feeble instrumentality—feeble from ignorance, inexperience, prejudice, tradition, superstition, and various other deterrent influences — should be aided with effectual supervision and control from head-quarters—supervision and control that shall consist in some thing more than the formulation of statistical tables, general observations on the intelligent interest of municipalities, and the well-known flowers of secretariat common-form books—but in the watchful, helpful, co-operation of superior authority—advising, instructing, guiding, training, and, if necessary, coercing. The Medical Department of the Local Government Board in England disposes, I think, of about 8,000 references in the course of the year, with a population of 28 millions. Who is there to perform a similar function in India, for the 250 millions of inhabitants? The Sanitary Commisioners? But they are purely and simply doctors, whose one business is to point out the insanitary influences at work, not to superintend the executive measures for the removal. The Government? but the Government knows less than the Sanitary Commissioners. What it comes to is that some secretary with a thousand-and-one other things in his head writes the sort of general sagacious observations that the light of nature enables him to make on a subject about which he knows little, and which he and his employers regard as a sleeping dog which it is on all accounts desirable to let lie. His memorandum is therefore, for the most part, couched in those phrases of vague generality which are the conventional language of authority, conscious of its ignorance and doubtful of its power. General results are stated, general conclusions drawn, regrets and hopes are expressed, general advice is given, general laudation bestowed; all are alike to a large extent valueless. Nothing comes or can come from it. The opposition party in the municipality knows that the reproofs or threats mean nothing, and is not intimidated; the progressive party finds no real help or guidance, or even encouragement, and things remain exactly as they were. The opposition rejoices in the fact of having been able to resist what it regards as a needless waste of money, the

Government solaces itself by the belief that it is training the people in the habits of self-government. Meanwhile thousands annually pay with their lives for this costly lesson.

Now let us see what the Army Sanitary Commission have to say of the actual state of things as they find it in 1885:—"With these examples before us, it is impossible to escape the conclusion that the vast civil population of India is decimated by epidemics simply because nothing effectual has been done to root out their causes, while the experience of the small municipal towns, with their uninformed administrators, furnishes us with the requisite caution that sanitary work is no chance matter, but one requiring education and experience to make it efficient."

"We have shown that, notwithstanding the greatly improved health under effective sanitary work of European troops, the reduction in death-rates has not continued, but has shown rather a tendency to increase, indicating the need of pressing forwards the sanitary works we have advised, not only to continue the improvements, but to hold the ground already gained, which the statistics show is in danger of being lost. A similar remark applies to native stations and to jails. But the most pressing question is how to save the vast civil population from the ravages of epidemics, a work which we now know by ample experience cannot be done by present methods." What reply have we to give to this momentous question?

Recommendations of the Royal Commission should be carried out.—The first essential, in our opinion, is to carry out the recommendation of the Royal Commission in its integrity, and to constitute in each Presidency an authority competent to superintend executively the carrying out of the reforms, the necessity of which is shown by the inspecting and statistical branch. Such a commission would watch with exactness the course of things in each municipality, would point out the main defects, to remedy which effort should be directed, and should have the power, subject, of course, in every instance to the control of Government, of enforcing the necessary action for their removal. It should be prepared to give to all municipalities the necessary help and guidance, to scrutinise all new projects, and, when asked to do so, to supply competent engineers who would furnish schemes of drainage, water-supply, and other sanitary improvements. At present a municipality which is prepared to carry out a great structural improvement is at a loss to find anyone competent to assist it in doing so. There is hardly, I believe, a single sanitary engineer in India, if the word be taken as implying special attention to, and familiarity with, the details of sanitary engineering as it is now carried on in England. The consequence is that municipalities who wish to embark large projects are at a complete loss as to where they should look or whom they should employ. Great schemes are undertaken with most inadequate knowledge, and enormous loss is incurred. Projects are put forward by engineers who are by no means qualified for the task, and the result is naturally disappointment and loss.

What is desired, accordingly, is such a body at the headquarters of each Presidency as would convert the sanitary supervision of the country into a reality. It would examine the facts with the insight of experts, would say authoritatively what ought to be done, and how it could best be done, and should have power, without dragging the Government into the quarrel, to enforce the fulfilment of its duties by an obstinate or recalcitrant municipality. It is of great politica importance, in the present state of public opinion, that the Government should come as little as possible into collision with the public, and especially with that noisy and troublesome section of it which comes to the front in public bodies, and expresses itself in the local press. A local government cannot afford to waste its energies, time, and popularity in quarrels with local bodies about sewage and water supply. At the same time it is essential that these objects should not be neglected. It would be far better, accordingly, that the supervision should be exercised by a body of experts, who would speak with authority, and would bear the brunt of any unpopularity which their interference excited. Upon no subject is heat more easily engendered or do fiercer quarrels rise. I would keep the Government outside of such quarrels.

Improved Means of Scientific Research.—Another deficiency of the sanitary administration is in respect of scientific research and experiment. It might seem incredible that in a country where the ravages of cholera are continuous, sometimes sweeping off 190,000 of the inhabitants of one province in a single year—where great epidemics strike down the inhabitants by millions; where cattle disease makes every year an enormous inroad on the national wealth — the entire

effort made by the Government to ascertain scientifically the nature of disease, and its influencing causes, should be confined to the maintenance of a single official, who receives a salary of Rs. 300 per month for devoting to scientific research the small leisure left to him by his other professional duties. However distinguished be the holder of such a post, and however great his zeal and ability, it is obvious that this is not a scale on which a Government can conduct such an inquiry with any reasonable hope of satisfactory result; and invaluable as have been the contributions of Dr. D. D. Cunningham to scientific research in India, it is certain that his powers of usefulness might have been turned to much better account if he had not been left to conduct an exceptionally difficult inquiry in complete isolation, and if he had been enabled to devote the whole of his attention to the task of investigation. Even this small attempt has been repeatedly interrupted, and within the last year or two all inquiry was for several months suspended during Dr. Cunningham's employment on other duties.

It is indispensable that there should be in the Government of India a department consisting of a staff sufficiently able and numerous, and provided with the necessary resources, to conduct scientific investigations into disease with all the precision and elaborate completeness necessary to such inquiries; and for this it is necessary that the attractions of the department and its prospects of promotion should be sufficient to draw into it a sufficient number of able men who would be prepared to find their career in it, and to abandon the chance of professional success in other directions. While the Department is constituted as it present, it is not very likely that scientific research will be highly esteemed—and, in fact, it has not been smiled upon officially. For years it was altogether suspended. Till quite recently the only microscopic examinations were conducted in a garret in which it would have been disgraceful to keep a dog, in an atmosphere so swarming with impurities and animal life as seriously to enhance the difficulty of experiment; and even now, the Government of India, which spends, one way or another, 70 or 80 millions sterling in the course of the year, while it affords the magnificent salary of £30 a month to the first physiologist in its service, cannot bring itself to the pitch of generosity of affording him the instruments to conduct his researches, or a porter to guard the premises in which his observations are conducted. *Pudet hæc opprobria dici;* but still more must we blush to be constrained to admit, *non potuisse refelli.*

When we know what the microscope has done, and is doing for the discovery of the causes of disease in Europe; when we know, for instance, in this country the important discoveries which year by year it brings to light, as, for instance, in the branches of pathology recently elucidated by Dr. Klein; when we remember, apart from the human mortality, what the cattle diseases of India cost her every year, it must be conceded, I think, that unless we accept the view that diseases are occasioned by causes which are not entities, and are undiscoverable, no intelligent Government can justify the omission to prosecute the search for these causes on some scale reasonably proportionate to their importance.

Necessity of Recurrence to Government Loans.—But it is of no use to have expert superintendence and scientific investigation unless funds be available for carrying out the improvements which that research shows to be essential and that superintending authority enjoins.

It is quite certain that every city in India ought to devote a considerable sum—far more than could by any possibility be defrayed from income—to works of structural sanitary improvement; in other words, if the work of sanitary improvement is to advance, a large number of loans will have to be contracted. It is equally certain that, as matters stand, the municipalities, especially the smaller ones, will either not be able to raise loans at all, or will have to raise them on ruinous terms. The experience of the Calcutta municipality, whose solvency is unquestioned, whose financial administration is notoriously prudent, and whose debentures stand high in the market as a first-class security, shows to what straits even the best borrower may be driven when he endeavours to raise money in markets so small and capricious as those of India. Then comes the question—Cannot the necessary funds be provided in some other way? and the answer is that they were so provided till a few years ago. Till 1879 the law was that municipalities might borrow of the Government, and of the Government alone. The Government satisfied itself that the loan was needful and expedient, and that the municipality was solvent. It then made the advance on the security of the rates and property of the municipality, reserving to itself the right, at

any time when capital or interest should be in arrear, of taking possession of the municipal rates and property, with a view to the liquidation of the debt. In 1879 this policy was abandoned. The Budget Resolution of that year disposes of the matter in a single sentence, remarking that the sums likely for the future to be required by municipalities were so considerable that they must be left to raise them independently of Government. The object was, probably, to relieve the financial department of a troublesome branch of business, and to obviate the large apparent increase of State indebtedness which the addition of municipal loans would occasion in the public accounts. Whatever weight attaches to these considerations can count, for very little as against the strong arguments which exist in favour of a recurrence to the old system. Indian municipalities are not bodies so constituted as to go with advantage into the money market for the purpose of raising loans. They know nothing about the subject, and it is not desirable that they should know. The experience of Calcutta shows that their necessities attract the attention of the money-lending powers, who proceed to turn them to a good account.

Nor need the Government of India feel the least anxiety at a nominal addition to the Public Debt. Her indebtedness is a flea-bite. In 1886-7 the interest charge was a little over 8 millions, but of this more than half was for debt incurred in the construction of railways and canals, which though frightfully weighted just now by the fall in exchange, are national possessions of the utmost value; while the interest on the part of the National Debt not so invested was less by three-quarters of a million in 1886 than ten years before; and a very competent authority* has pointed out that India stands alone among the countries of the world in possessing valuable property, which more than counterbalances the whole of her indebtedness. "India," he says, "has, in reality, no debt whatever; her assets far exceed her liabilities. Her balance-sheet is such as is possessed by no other country, it is the most favourable in the world."

On the other hand, public opinion in England and India will not allow the Government of India to go on much longer leaving the sanitary condition of every city in the Empire in the deplorable condition that now prevails. Death-rates of 50, 70, and even 100 per mille are horrors which call for the interference of the ruling power, no less than the occasional famines, the mortality of which attracts such a disproportionate amount of public attention. The preventable mortality, which the barest compliance with sanitary rules would put an end to, is, it has been estimated, every year twice as great as that of either year of the famine of 1877-78, which was the worst famine ever known in India. Such a state of things cannot be allowed to continue. The Government must insist on the necessary reforms being carried out; but its doing so becomes a mere mockery if it does not at the same time render the carrying out of reforms a matter of practical possibility. No one but the Government can supply the necessary funds, and it could do so without either risk or loss, and also without the disadvantage, whatever that may be, of nominally increasing the national debt. If a stock such as that recently issued by the Chancellor of the Exchequer were created in India, entitled Local Works Stock, and placed on the market at favourable times, there is no reason to suppose that the necessary sums would not be obtained, and no disturbance need be occasioned to the other borrowing operations of the Indian Government. I believe that such a stock would be popular with native investors, and it would go some way at any rate towards meeting the necessities of the municipalities. The money might be lent at 5 per cent., at which rate municipalities would be glad to borrow; the Government could certainly get money at a cheaper rate, and might thus reap a profit on the transaction.

Sanitary Education.—The various Governments have done something in the way of diffusing among the people more knowledge of the laws of health. Text books have been widely circulated in the schools. But here, again, there is room for something more thorough and effective. Some acquaintance with the art of living in health ought to form a necessary part of every educational curculum. The subject might surely form one branch among the many which the universities recognise as worthy their notice. Such knowledge would, one is inclined to think, be as practically valuable to a young Hindu as the refinements of European literature, or the hazy depths of metaphysics, to which he is now introduced by his instructors. Still more essential is provision for the training of natives as sanitary engineers, sanitary inspectors, health officers, and other like appointments.

* "Grammar of Indian Finance," by T. Hesketh Biggs, Finance Department, Government of India.

When the Government has provided effectual supervision and control, and the funds for carrying out improvements, there will be need of a class of officials, such as the important body within recent years created in England —men whose knowledge, power, and skill are thoroughly tested, who have duly qualified themselves by meeting the appointed test, and on whose recommendations confidence may be placed. At present no such class exists.

I would also with great deference, and with a due consciousness of the resentment occasioned by any suggestion that the Civil Service could possibly be better than it is, venture to suggest that the civilians might with advantage complete their education in this country by acquainting themselves with some of the elementary facts connected with the public health. They are and must be the leaders in all improvements. The attempt to displace them has already collapsed; and the sanitation of India would not be what it is if the Civil Service had had any real knowledge of the subject, or any of the intelligent interest which knowledge engenders. Civilians are generally chairmen of municipalities. In Calcutta I am sorry to say that the attitude of the civilian chairman has been rather that of defending the shortcomings of the Commissioners, and resisting reforms urged on him by the Government and the public, rather than of hearty and enlightened sympathy with the cause of reform. The *lues apologetica* is not one of the diseases which appears in the Government Tables, but it is a very bad official malady, and it has raged in an acute form in the Calcutta municipality.

Another desirable reform would be the creation of a superintending and advising body in England, who would be in touch with the Provincial Commissions in India, and keep them supplied with all the newest methods and appliances in England. The Army Sanitary Commission is, of course, a criticising authority of the highest value, but its criticisms generally reach India several years after the period criticised, and they filter through the Secretary of State. Owing to the want of such superintendence many great mistakes are made. The drainage of Calcutta was designed on the now condemned system of combined pipes for sewage and rainfall. Again, such inventions as Shone's system of sewerage was recommended as especially fitted for India; there is no one in India qualified to pronounce an opinion. Or again, the very interesting process now at work at Acton,* by which sewage is purified by means of porous magnetic iron, suggests a means of dealing with Indian sewage, and purifying the water of Indian tanks, which would revolutionise the health of the country. The whole question of the best means of sanitating Indian towns ought to be settled authoritatively by a body of competent experts examining English improvements on the spot.

Dangers from Excessive Population.—One other subject I ought to touch upon. It is the consideration of the effect of the British administration of India in arresting or attenuating all the main destructive agencies—war, pestilence, and famine—and the consequences of this upon a population which not only is not influenced by the prudential motives which in other countries tend to defer marriage and to check the growth of numbers, but it actually constrained by religion and usage to increase it to the greatest possible extent. It may be said roughly that every marriageable person among the 200,000,000 produces children at the first moment that it is physically possible to do so. The possibility suggests itself that at some future time the vast numbers of the inhabitants may give rise to difficulty and occasion suffering. Sir H. Maine has recently referred to this as one of the peculiar trials which are incidental to good government, and one which is likely to be experienced with acuteness in India. "In no country," he observes, "will there be probably a severer pressure of population on food." Considerations of this nature present themselves in every improving country. The stern truths which Malthus proclaimed have been more often ignored than answered. It is becoming clearer year by year, as the human race gains more complete mastery over the great destructive agencies, with which for ages it maintained a scarcely equal contest. Now that mankind is learning effectually to protect itself, as, too, the new fields for human enterprise are being rapidly absorbed, the conviction is more and more forcing itself upon us that the unrestrained growth of population will come to be regarded in a very different light, and that the teaching of religion, morality, and common sense will be pointed in a different direction from that of former times. So long as enormous portions of the known world were virgin soil, awaiting

* See International Water and Sewage Purification Company, 18, Mansion-house-chambers, 11, Queen Victoria-street.

man's industry to be turned into sources of plenty; so long as even such a country as England was to a large extent uninhabited; so long as great epidemics swept about the world, threatening, and in some places actually effecting, the extermination of the race; so long as war occupied the main mass of humanity in projects of mutual slaughter; so long as famine, owing to the absence of means of communication, was an ever recurring source of wholesale mortality; so long as the chronic misery of life, the ignorance of all remedial arts, the abject and defenceless condition of all but a tiny fraction of society so long as all these causes kept the numbers of the race at a standstill, or made them retrograde, it was natural that the feelings which embody themselves in religious, and moral, and economical creeds should sanction the indefinite increase of the race, irrespective of any consideration of the means for supplying the necessities of the new comers, and of equipping them properly for a successful struggle for existence. That epoch is passing away, but the sentiments which it engendered survive. The poorest, the feeblest, the most unfortunate, the most diseased, still consider themselves entitled, as by the law of nature, to launch into existence beings whom they are unable to provide with any one of the conditions of happy, useful, or virtuous life; who, but for the precarious aid of charity, would perish at once, and who are, as a moral certainty, destined to lives of want, degradation, and crime. Hence the ever-swelling tide of misery which is the opprobrium of modern civilisation and the despair of the philanthropist. Above this class comes a great stratum, not indeed of the same degree of reckless unthriftiness, but who think themselves justified in exposing themselves and their children to all the inevitable accidents of existence, and who, on the occurrence of these accidents think Heaven and Society very much to blame for the result which they have deliberately brought upon themselves and their progeny.

Till it is recognised that the reckless production of children, for whose maintenance, education and start in life no reasonable provision has been made, is a grave offence against them, against society, against humanity and morality, and, as the sum total of humanity and morality, religion, there seems no probability that there will cease to be, at the bottom of the social scale, a vast residuum of suffering and degradation. In proportion as these truths are realised will that residuum be diminished, and the sound portion of society gain upon it. But the way to that consummation surely lies in the enforcement of these truths, in raising the standard of comfort and happiness, in awakening the sense of responsibility, in fortifying the habits of prudence and self-restraint, not by leaving mankind in its misery and suffering to be the helpless victims of disease, and consoling ourselves with the reflection that their numbers are, at any rate, reduced by the operation of those dreadful retaliatory processes by which nature avenges her outraged laws. Nor is it with death alone that we have to deal. An improved standard of public health means, not merely only so many fewer deaths, and thus many fewer families left without their natural means of support, and so sinking to the abject level of destitution, but it means the whole standard of health raised. There are probably, the statisticians tell us, twenty cases of severe illness for every death. To put it in a concrete form, if it is possible, as we assert, to prevent 2,500,000 deaths in India, this implies the preservation of 50,000,000 of people in health who would otherwise be the victims of disease.* Now one may doubt about anything, but it is surely difficult to conceive a more substantial, a more practical benefit conferred on a community than the prevention of this vast mass of suffering. Believing it to be attainable, we will not be deterred from endeavouring to attain it; we will not salve our consciences in a cynical indifference to human suffering by remote speculations that some day or other there will be too many inhabitants of the globe.

In the first place, why are we to suppose that the laws of fecundity must always remain the same, or that manners and customs, which seem to be the instinct of a community threatened with extinction, will continue to act with equal force in altered circumstances. Why are we to suppose that the inhabitants of India, ingenious, quick, receptive, skilful of hand, and artistic in taste, are to confine themselves, as in the past, almost exclusively to agriculture, and will not some day be in a position to take a hint from England, which, for its small population, imports more than two millions' worth of food per week.

* As indicating the enormous prevalence of cholera in India, it may be mentioned that in 1885, out of a population of 450,000 no less than 228,000 persons received treatment in the public medical institutions of that city.

In the next place, there are in India various special circumstances which go far to alleviate the force which considerations of this nature may have in other countries. For one thing, while the cultivated area is, exclusive of Bengal, 150,000,000 acres; the uncultivated area, capable of cultivation, is 79,000,000; so that there is an area more than half as large as the present cultivated area which might be cultivated and is not, and which only needs the arrival of man to render it a source of supply, and there is another 12,000,000 as to the cultivability of which the Agricultural Department cannot speak.

But even in the cultivated area the outturn is that of the poorest agriculture, and admits of enormous increase. The experts in English agriculture consider, I believe, that the yield might be increased by a third—but compare it with that of India. The Famine Commission reckoned the area under food crops of the whole Empire at something like 166 millions of acres, and the average outturn at 11 bushels per acre. More recent authorities, I see, put the out-turn at 9 bushels, that is, some twenty bushels per acre below that of England. Supposing, as we have a perfect right, from experience of the Indian model farms, to do, that the yield might by proper culture be raised to that of England, we have an additional food supply, enough, for an additional population of 400 millions.

When we see how vast areas, as in the Punjab, North-Western Provinces, and Bengal, in the deltas of the Kistna and Godaveri, have been converted by irrigation into a scene of plenty, which smiles sweetly but contemptuously at the baffled demon of drought, or projects like that of Peryar in the south, by which an entire river is diverted from its natural course, and the watershed of the Western Ghat employed to irrigate the barren eastern shores; when we reflect on the vast volumes of water which now roll uselessly to the sea, close to the deserts of the Punjab and Rajpootana, which they would convert into a garden; when we look at the barbarous waste with which the forests of India have been treated, and which has destroyed and is destroying vast mountain sides, as, for instance, the whole range of the Siwaliks, which are now barren rocks, actually destroying the land at their base by sand-torrents, but which might easily become inexhaustible supplies of forage and fuel; when we look to the small degree in which one great means of support, fish, is utilised—and fish happily increase, like the human race, in geometrical proportion—I think that the hour at which we need stay our hand, in matters like sanitation, because we are afraid of the results of our own action, is still not within measurable distance. Five centuries ago England was swept by a disaster as dreadful, more dreadful indeed than those which now affect India, and a third of its inhabitants destroyed. Suppose some hardy scientist had suggested that such visitations were preventible, and the answer had been made by some complacent objector, "You must take care what you are about. The Black Death is a loathsome and terrible malady, but such nutural expedients for the reduction of population are part of a beneficent ordering of events. They are blessings in disguise. These islands at present contain nearly a million of inhabitants as it is. We have constant famines, every seven years on an average; life is already hard enough; the condition of the labouring classes is deplorable. Thousands of cattle have to be sacrificed every year for want of forage. The death-rate is not much now more than 70 or 80 per thousand, human life averages already 20 years in length. Take care how you interfere with the stern but useful and wholesome operations of nature in sweeping off redundant population." Happily, another answer was given, we have now in these islands, 37 millions of people, a large portion of whom live in a degree of comfort which princes then could not dream of—the poorest of whom are well off as compared with the poor of those days. The great epidemics have disappeared, cholera stands baffled at our shores; life, to the great mass of the people, is longer, brighter, happier, more exempt from dreadful vicissitudes. We believe that a similar future is in store for our fellow subjects in India; and we appeal with hope and confidence to the enlightened public opinion of England to aid in the endeavour to hasten the consummation of this long-wished for result.

DISCUSSION.

The CHAIRMAN said—I was glad to have the opportunity of presiding on this occasion, because, from my long connection with the Army Sanitary Commission, I have arrived at some understanding of the Indian sanitary problem. I think that the Society is to be much congratulated on the very comprehensive and able paper which has been placed before them to-night by Mr. Cunningham, and in any remarks which I can make I can only endeavour

to enforce what he has said. The more important portion of the problem relates to the incidence of cholera. In was the efforts which we made to arrest the progress of that disease in England which laid the foundation of our sanitary legislation; and if the causes which favour the development of cholera in India are removed, the prevalence of other preventible diseases will be checked. But cholera affects not only our own population: it affects our neighbours, and interferes with the progress of our commerce. At the Hygienic Congress at Vienna, the fact was recognised by all leading European sanitarians that cholera was not to be stopped by quarantine, but that it could be prevented by sanitation; and the question was asked of us, the English representatives, why, if you can prevent cholera from obtaining a foothold on your own shores in England, cannot you equally prevent it being born in India. No doubt the conditions which prevail in India may be more difficult to overcome. But, as Mr. Cunningham has told you, we have had for years admirable reports on the sanitary condition of India, and all those reports concur in saying that cholera occurs when the sanitary conditions are defective, and does not occur in the presence of good sanitation. The last published report from the Sanitary Commissioner for Bengal, viz., that for 1886, gives an admirable instance of this now well-known fact. The districts of Bengal, near the Ganges, have long been cited as the birthplace of cholera, whence, when epidemic conditions prevail, it spreads over India, and penetrates to Europe. The Sanitary Commissioner, in speaking of Serampore, where between 7 and 8 per 1,000 died of cholera in 1886, says the Rishra village is a breeding ground of the disease. It is chiefly occupied by coolies. The land belongs to Government (khas mehal lands), but it has been farmed out to the mill proprietors, who in their turn have let it to others, and the latter enjoy large rents by letting out the huts, constructed by them in the lines, to coolies. Some of these lines are terribly overcrowded, and the huts are ill-constructed and hardly raised above the ground, and the natural drainage is intentionally obstructed for manufacturing purposes. The coolies, as well as the other *busti* people, are filthy in their habits; their food is unwholesome; and they are altogether indifferent to sanitation. To check these outbreaks, Mr. Ritchie suggests that a clean sweep of the lines be made, that the land be drained and new lines erected, the cost being met primarily by the mill proprietors, secondarily by Government, who get a large rent from the lands, and thirdly by the municipality. But owing to its being Government land, and the Government being indifferent, the municipal commissioners are helpless in the matter. But the same report instances, as a proof that sanitary measures will prevent the prevalence of cholera in these its breeding grounds, what has taken place in the Champdani *busti*, in the town of Baydyabati, which used always to be frequented by cholera, and which did not suffer in 1886, the reason alleged for this immunity being that the *busti* had been placed in a good sanitary condition by the construction of a new road constructed through it, and the provision of latrines, the daily removal of refuse, and the supply of filtered water. Thus exactly the same conditions which produce cholera in England also produce cholera in India. These conditions are intensified, no doubt, by the climate, but if dealt with in detail they are easily removable, especially if the desire to remove them exists. At the Army Sanitary Commission we have reports *ad nauseam* on what is required to be done to make India sanitary. But the evils still remain, because apparently it is nobody's business to see to their removal. The same thing was the case in England until, under the pressure of approaching cholera, we conferred the duty of enforcing sanitary measures upon the General Board of Health. If, therefore, we are to check cholera and other preventible diseases in India, the further step pointed out by Mr. Cunningham is now required. That step is what was recommended by Lord Derby's Commission on the Sanitary State of the Indian Army in 1862, but which recommendation has been entirely overlooked. It is simply to do what was done in England in 1848; it is to establish General Boards of Health, with power to insist on improvements being effected in cases where insanitary conditions prevail. Till the Government of India establish such Boards, it is in vain to say that they have at heart any real desire for sanitary improvement, or any desire to check the progress of cholera. The establishment of some system of enforced sanitation is a duty that the Government owe to the people of India. Improved health means improved efficiency in the power of production, increased wealth, and increased happiness among the people. But the abolition of insanitary conditions in India is equally a duty which the English Government owe to the world, in order to prevent India from continuing to be the breeding ground as well as the hotbed for the propagation of cholera. I trust that in the discussion which will follow this interesting paper these questions will receive consideration.

Sir GEORGE CAMPBELL, M.P., said the subject was far too vast to discuss in the time now left, but he might say that he thought Mr. Cunningham had proved too much. He seemed to assume that sanitary science was more complete than it was, and that the problem of removing disease from India was plain and easy, and in that view he could not agree. Then, he also seemed to advocate putting a stop to local self-government, and subjecting the country to some kind of sanitary despotism. He seemed to suppose that India had been governed for the last hundred years without any regard to the health of the people, and that no attempts had been made by the authorities to remedy the evils which were before their eyes. Now, as one of those who had exercised some of the functions of government in India, he must say that

the authorities had had this subject before their minds for the last generation, and had been most anxious to grapple with it, and if they had not succeeded so completely as they could wish, it was because the problem was much more difficult than Mr. Cunningham seemed to suppose. He did not think sanitary science had as yet reached anything like perfection, though he admitted that great steps had been taken. For instance, if people were better fed, better cared for, and better housed, no doubt their health would be better. But he did not believe that disease was yet understood, either in its nature or origin, nor how it could be put a stop to. He should not like to put forward anything like an opinion in conflict with professional views on such a subject, but from his own personal observation he entirely disputed the notion that cholera was a preventible disease, and that it could be entirely abolished. On the contrary, he had found that it broke out in the most unexpected places sometimes, though no doubt common-sense and good sanitation would do much to mitigate it, and all other diseases. An epidemic would sometimes attack sanitary as well as insanitary places, and would carry off the rich and well cared for almost as much as the poor and wretched. He believed the matter must be approached in a humble spirit. He had used every means at the disposal of the Government in several parts of India to try to trace the course of those waves of fever which at times seemed to spread over the country, and some small measure of success had been obtained, but he did not think they had at all got to the root of the matter, or succeeded in understanding how and why that great wave advanced as it did. He deprecated the idea that this matter had been wholly neglected, and if more success had not been attained it was owing to the inherent difficulties of the question. The difficulties were not to be got over by any simple measure; it was not to be done in a day, nor should everything else, including local self-government, be sacrificed to it.

Surgeon-Major PRINGLE, as lately a member of the Sanitary Department in India, and who had had thirty years' service in India, said it was impossible to thoroughly discuss this question then, especially as there were so many different aspects of it. He had seen more of cholera than most people, and had suffered from it in passing through one of those Calcutta *bustis* which the author of the paper had alluded to, and though he escaped, a brother officer in the next house was carried off by it. You could not prevent cholera occurring where it was endemic, but you could limit the outbreak and prevent its spreading. He desired to speak with all freedom from bias on this subject, but he was at Saharanpore in the great epidemic of 1879, and saw the first case arrive. He saw the head of the department as he passed through on his way to Simla, and knew he was told from what was then happening that the history of 1867 was going to be repeated, that there would be a terrible outbreak at Hurdwar. This was the most unsuitable place in the whole of India for a great fair; it was the apex of an angle, in which the people were so crammed together, that when a barrier broke upwards of 30 were killed. It was not to be wondered at that cholera should break out there, and when it did the people all rushed to Sarahanpore. As Deputy Sanitary Commissioner he at once wrote to the magistrate, begging him not to allow the crowd of cholera-stricken pilgrims to come there, but to order that they should be stopped at a certain station, where he would make arrangements that they should be taken by a special train and not mingle with general traffic. The head official of the railway was prepared to make the necessary arrangements, but the only reply he got from the magistrate was that nothing could be done without orders from the head of the district, and the result was that all these people were packed in the trains like sheep, and sent all over India. The then sanitary head of the Government thought that a harmless proceeding, but it did not prove so in the result, for it produced great mortality amongst the British troops in the north, and a wave of cholera which spread all over the country. In justice to the native gentlemen in the North-West Provinces, and the various municipalities, he must say that they were not only capable of taking part in the various duties devolving upon them, but did so most willingly and effectually. There was a good instance of this at Muttra; there was not a station in India which could touch it for cleanliness; and the funds necessary for the purpose were provided most willingly. At some of the places named, where the mortality was said to be 70 per 1,000, he believed it was very much more. The Sanitary Commissioners of India were to blame for a vast amount of mortality in the North-West Provinces, by permitting a system of irrigation, which was really inundation. It was the worst soil in the country for irrigation, owing to the nature of the subsoil, which held the water underground, and rendered it cold and barren. Unfortunately this kind of irrigation was being extended.

Dr. PAYNE feared that his remarks would scarcely be acceptable to some of his hearers, and they would be confined to the condition of Calcutta. His account would differ very greatly from that which had just been given as to the conduct of municipal matters, though he believed the proceedings of municipal commissioners, and of the natives generally amongst the more manly races, were as had been described. He knew the liberality of the native gentlemen of Muttra, and could not but reflect with bitterness on the totally different spirit he had witnessed in Calcutta, where he had resided for twenty-eight years. He was convinced that the root of the evil lay too deep to be reached by any ordinary means. The deficiencies of sanitation had been persistently pressed upon the authorities, but without

effect; not that there had been any want of cordial approbation and sympathy in high places, for the Provincial Governors, Viceroys, Secretaries of State, councils, and the Army Sanitary Commission had one and all, from year to year, condemned the conduct of the Calcutta corporation, but that body remained unmoved, and he feared would remain so. In 1876, the introduction of the elective system placed the life and health of the people of Calcutta in the hands of a class of men who had not a single qualification for such a trust. Education in India had done nothing towards creating or developing the qualities which were above all others required in a custodian of the public health. We had filled the Bengali with the contents of books, but left him in his life and character, in his thoughts, purposes, motives, and methods, exactly as he was in the days of Nunkomar. Public duty and a sense of public spirit were not scholastic attainments, and where they did not exist, intellectual subtlety, quickened by the study of law and logic, tended rather to suggest dialectical means of evading duty than inducements to perform it. Of this there had been voluminous evidence in the municipal debates in Calcutta. The elective system was introduced against the advice of the most experienced and able officers, who knew that the class of native gentlemen who alone among their countrymen were fit for such a trust would never submit themselves to the incidents of an election. They knew also that election would place absolute power in the hands of the very men who, not many years before, had used their utmost endeavours to keep the town without a sewer or a drop of clean water. Soon after the introduction of this system, Sir Ashley Eden, whose knowledge of Bengal was unrivalled, succeeded to the government of the province, and in his review of the first report of the municipality, he pointed out in very forcible language that the election had resulted just as had been foreseen when a former administration had rejected the electoral system as unsuited to native society in India. Sir A. Eden referred to the personal results; the material results are written in a twelve years' record of resistance to sanitary work, of misapplication of funds and deaths from preventible disease reckoned in annual thousands. A very serious mistake may be made with regard to the health of Calcutta. It was his duty as Medical Officer, in 1877, to investigate a curious enigma which seemed to exist. There were thousands of people living in places where earth, air, and water were saturated with filth, and yet, year after year, the recorded death-rate amongst them was not more than 30 per 1,000; not at all an excessive rate for an Eastern town. There were much higher figures in the suburbs, and it was supposed that the registration was imperfect. On inquiry into the method of registration no available sources of information seemed to have been neglected, but there was necessarily a considerable transit of population between town and suburbs, and he found that many people contracted sickness in the town, and died in their suburban homes, swelling the suburban death lists, but not affecting the town rates, as these people were not included in the town census. Again, amongst the resident Europeans the death-rate was singularly small, a rate which would be envied by many towns in England, but the European population was too small for its death figures to affect appreciably the general rate. On the other hand, the only fixed population, the mixed races, the Eurasians, were dying at an enormous rate, about 50 per 1,000. He also found that amongst the male native population at about the labouring ages, the death-rate was quite nominal—only nine or ten per thousand, and the enigma really seemed insoluble. An accidental solution came about. Being engaged in inquiring into a local outbreak of cholera in the town, he found that the population consisted largely of natives of the interior, who had only temporary homes in Calcutta, and it was the habit of these people to take flight directly they became sick, so that the deaths amongst them occured elsewhere, and did not appear in the town records. It struck him at once, that if this was a type of the whole of Calcutta, there was the solution of the enigma, and further inquiries established that it was typical, and that an enormous proportion of the native population consisted of this migratory class; it was established by every conceivable test that not less than one-half of the native population was of a migratory character, especially the male population at the labouring ages. That was the whole explanation of the nominal death-rate, and it showed that the real death-rate of the town must be enormously high—higher, even, than that of the Eurasians—because many of these lived under all the sanitary advantages of an English town. He estimated the death-rate at 50 per 1,000, but later evidence had convinced him that 60 would be nearer the truth. He was convinced that two-thirds of this mortality was preventible, and he maintained that cholera could be prevented in the vast majority of cases, with all deference to Sir George Campbell, for he had seen too many outbreaks suddenly and completely arrested, and recurrence prevented, to admit of any rational doubt on this point.

Dr. GEORGE BUCHANAN, F.R.S., said he was sorry to see the fatalistic tone which had been taken in the course of the discussion. They were told that education was a failure, and that nothing could be done to improve the physical circumstances of these people—that it was beyond the ability of Government to do so. He should have thought that there was a larger idea of statesmanship in its application to the business of public health in India, but of that he had heard no suggestion in the discussion, although there had been some able suggestions in the paper, such as appeared to be adapted to the transitional state, described as that of India at the present time, when people were

very imperfectly educated in the rudiments of sanitation. He was sorry that these suggestions had not been examined rather than put aside as unpractical. Certain things must be admitted. The insufferable filthiness which spread cholera through the Delta of the Ganges had been mitigated, and could not the commonest principles of statesmanship go further? When they knew of people washing, drinking, and excreting in the Hooghly water, using it indiscriminately to come into their mouths and out of their bowels, and heard that filthy tank water was washed in until it was the colour of porter, and then went straightway to feed the wells from which the people drunk, how could it be wondered at that cholera should spread. Something more must be done than to introduce filters, or supply water by stand-pipes which had to be lowered because the pressure was not sufficient to reach 6 ft., and where a two-gallon jar had to be put for a quarter of an hour under the pipes before it could be filled. Things of this kind could be remedied by most commonplace sanitary administration. If they were to be told that the inhabitants of India might perish as they pleased for want of knowledge, and that they must die of their fevers and home-bred preventible diseases, at any rate it might be remembered that there was one disease—and he thanked God for cholera—which would not be confined to India, but insisted on telling the tale to Europe; and the peoples of Europe would not be content with England complacently saying that she, knowing the value of sanitation, could keep the cholera out of England, and did not want quarantine; they would want to know why she should keep cholera up in India, and Europe was beginning to say that she was responsible for these things which affected Europe. He had in his hand a volume by Dr. Koch, which, besides describing bacilli and other such things, gave an account, which was being read all through the German empire, of the condition of India and of Calcutta, and it was illustrated with pictures of what was going on, and showed to the shame of England, and to the astonishment of Germany, what was being done and suffered at the principal seat of the English Government in India.

Mr. Martin Wood thought that Mr. Cunningham had laid too much stress on the authority of the Army Sanitary Commission, and had reproduced a very old fallacy in his comparative figures, in which he showed the death-rate—in a series of years ending with 1859—was 69 per 1,000. He believed that that included the military casualties at that period, or, if not the killed in battle, certainly those dying on service under the severe campaigns of the Sikh wars and the Mutiny; and that being assumed as the starting point, the much lower rate had been taken to show the progress of sanitary improvement. And it was a similar error to compare the famine years and the Afghan campaign, in the 1870-9 period, with the single year 1885. Although there was much valuable matter in the paper, he ventured to suggest that it was altogether too darkly drawn. It tended towards introducing exotic systems of sanitation into India which could not be thoroughly applied, and which would not be suitable to the circumstances of the country.

Sir Henry Acland, K.C.B., F.R.S., said though he was only an English observer, he took great interest in the progress of affairs in India. Many years ago he had advised that there should be an interchange between the great sanitary departments which were springing up in this country and those existing in India. He was glad to believe that the great Indian health officers, such as Dr. Cunningham, Dr. Payne, and others, were coming to this country, and were able and willing to make known some grave truths on this matter. At that hour of the evening it was impossible to express with adequate force the impression which this subject would produce on any serious mind. The magnitude of the Indian question, the vastness and peculiarity of the people, were hardly appreciated by the average Englishman. In the paper—while he did not entirely agree with all it contained—there was a most striking picture of the Indian village, one which Dr. Buchanan had just enforced. The horribly filthy condition of the water tanks was, in this country, inconceivable; but it was a fact, and yet they were told by some people that cholera was not in any degree preventible. Anyone who appreciated that picture hardly knew how to reply to such a statement. On the other hand, when he was told the Government had done nothing in the matter, he hardly knew how to answer that. One of the things in which he had taken the greatest delight, in connection with the scientific libarary in the University of Oxford, had been the collecting, through his friend the late Sir Bartle Frere, the various sanitary reports, which were a splendid monument of the government of India by the English nation. He might say, from personal experience and knowledge of public officers, that there were no men for whom he had greater respect and esteem than for many of the permanent officers, sanitary and others in this country. He had no doubt that one reason why so little had been done was simply that the problem was so vast. One or even two generations were nothing in dealing with such a problem. He maintained on behalf of England that she was attempting to improve the health of the people, and if she continued to possess India she would succeed. The remarks of the Chairman, like those of Dr. Payne, were of the gravest character. The Chairman said we had only to do what had been done in England—to have sanitary authorities; but then another gentleman of large experience and knowledge, said these authorities would do nothing. Those two antagonistic statements showed the magnitude of the question. The coming generation—the men who were learning the nature of sanitation—would, if England continued to govern India, do whatever is possible. As in this country so in India; it must, from the nature of

the case, be to a great extent a question of education. Many years ago he had been ridiculed for saying that a great deal of the sanitary question rested on the education of the people. But what did the education of the people mean? Not merely cramming for an examination, but in raising up virtuous, wise, and patriotic citizens, who would do their duty in their various stations of life—authorities ruling with wisdom, the people obeying with intelligence. This education was now being attempted in India; whether rightly or wrongly, he would not presume now to give an opinion. There were excellent books bearing on public health, and there was no reason why they should not be largely increased, widely disseminated, and adapted to the native population.

Mr. T. H. THORNTON, C.S.I., said that, having been for nearly twelve years secretary to a provincial government, he had seen a good deal of the work of sanitation in India; and he must say he thought Mr. Cunningham had somewhat exaggerated the situation. Dr. Payne had already spoken of the mortality of Calcutta, and with regard to the Upper Provinces, with which he was best acquainted, there was no doubt that one cause of the apparent high mortality was improvement in registration. In India registration was not compulsory but voluntary, and until the people began to understand its importance, it was extremely defective. Year by year its importance was more recognised, especially as affording evidence of the date of death, which was often required in law cases, and thus it was becoming more and more accurate. One good result of this was to show the enormous rate of mortality, but, at the same time, the improvement which had been effected by sanitation could not be proved by statistics. He was quite certain there had been a great improvement in the northern provinces, at all events. With regard to the municipalities, Mr. Cunningham had drawn a terrible picture, which had been supported in the case of Calcutta, but it was certainly not a true picture of the municipalities in the north-west. Many of those were most anxious to co-operate with the government in the work of sanitation. There were, no doubt, great difficulties in the way, one being the almost total absence of sanitary science and engineering. This was now being met, sanitary engineering being included in the course of study at Cooper's-hill. Another difficulty was that of finding money. How were the magnificent appliances which some people thought so necessary to be provided for a poor population? A water supply had been provided in several places—at Lahore, Umballa, Peshawur, and Simla, and a great deal of work was being done with very limited means. There was a great deal in what Mr. Cunningham said about the Government refusing to lend money to the municipalities for such purposes, and consequently, they had to borrow at an enormous rate of interest. That had effectually stopped one very great improvement —the introduction of a water supply to Delhi, for they could not afford to borrow at 8 or 10 per cent., and Government would not lend to them at $4\frac{1}{2}$. The remedy suggested for all these evils was the establishment of Boards of Health, with executive powers, but perhaps Mr. Cunningham was not aware that in 1867 or 1868 the suggestions of the Commissioners in England were adopted, and Boards of Health were established in every district of the province with which he was connected. And they were all abolished as absolutely useless. The best Board of Health was the district officer, advised by the doctor and engineer where necessary. They were perfectly ready to do the work if they had the money. The greatest source of mortality in India was fever, and one of the causes of the prevalence of fever was the irrigation canals. Wherever irrigation was introduced on a large scale, there was no doubt that fever followed in its wake. This was in great measure because drainage did not go hand in hand with irrigation. In districts not properly drained, no high-level irrigation should be permitted; it should be confined to a low level, because where the water had to be slightly raised it would be economised, there would be no more flooding, and the health of the adjacent country would be immensely improved.

The CHAIRMAN, in proposing a vote of thanks to Mr. Cunningham, remarked that the success of the Board of Health in England, and indeed of the Local Government Board, depended entirely on the fact that it contained amongst its members persons who were experts in sanitary knowledge; the Boards to which Mr. Thornton alluded failed because they did not contain sanitary experts amongst their members.

The vote of thanks having been carried unanimously,

Mr. CUNNINGHAM, in reply, said some misapprehension had evidently arisen from his having been obliged to deal with some points very summarily. In the criticisms he had offered on the administration of sanitation in India, nothing was further from his thoughts than to suggest that there was anything like apathy on the part of Sir George Campbell, or the various other able administrators who had been from time to time at the head of the Indian provinces. No one had admired Sir George Campbell's Indian administraiion more than he had, or followed his career with greater interest. What he wished to urge was a more intelligent and systematic procedure in dealing with the subject. Much harm was done by the notion that diseases were mysterious, not preventible, that they must be approached humbly, to use Sir G. Campbell's phrase. Of course, in one sense, cholera, or such maladies, must be approached humbly, because the lives of men were in the hands of God; but scientific men, such as Dr. Buchanan and Sir Henry Acland, really did not know what people meant when they said that disease of this sort was not preventible. They had proofs from day to day,

and from year to year, that wherever they cleared out filth, and prevented people from using foul water, contaminated with human excreta, for drinking purposes, there cholera ceased.

Sir GEORGE CAMPBELL—No.

Mr. CUNNINGHAM said he did not mean to assert that an epidemic, when once on foot, would at once come to an end, but he challenged any one to show a case in which, when sanitation had been effectually carried out, epidemics of cholera had occurred. They disappeared before sanitation as completely in India as they did in England. There was now good reason to believe that cholera would never effect an entrance into England again, and in the same way some parts of Calcutta were made as free from cholera as London, whilst in those which were still left in a filthy condition cholera persistently occurred. Cause and effect were seen as plainly in this matter as in any other branch of natural science. Along with humility, therefore, they ought to exercise common sense, and to say that this dreadful scourge could be put an end to whenever they pleased. The Government had not had an executive body of men of sufficient knowledge to carry on sanitation effectively. He quite agreed with what had been said about the way in which some parts of the country had been flooded by canals, and such a thing could not have occurred if there had been such provincial bodies as he suggested, with knowledge of the snbject and power to make itself felt. Sir George Campbell seemed to be under the impression that they wanted to create a sanitary despotism, and to do away with local self-government, but that was a complete misrepresentation of their views. They did not want to destroy it but to guide it. These local bodies, of perfectly ignorant people, were elected and left without that control which the Local Government Board was constantly exercising over public bodies in England, to keep them up to their duty. There was no apparatus of that sort in India. They wanted not to abolish local self-government, but to improve it: to guide it to see that it was really acting for the benefit of the country, not for perpetuating grievances which might otherwise be removed. To complete the system they wanted not only commissioners in India, but a body of competent persons in England to keep the sanitary authorities in India acquainted with what was going on here, and to convey to the millions of India the advantages of all sanitary discoveries. Ever since he had known Delhi they had been trying to get a proper water supply, and the loss of life owing to this want, both amongst the troops and the people, had been, and continued to be, enormous. Yet no place was more easy to supply with water if there were only people there who knew how to do it. Again, with regard to the tanks, they knew how to purify them, if they only set to work in the right way, and shut them off from all human contamination, put in them the oxygenising vegetation which abounded in India, and used means of purification such as he had seen at Acton and elsewhere. It was quite possible, at a cost which would be within the means of the community, to supply all the tanks of India with pure and potable water, instead of the filthy and dangerous liquid they now contained.

APPLIED ART SECTION.

Tuesday, January 31, 1888; E. J. POYNTER, R.A., in the chair.

The paper read was—

THE MONUMENTAL USES OF BRONZE.

By J. STARKIE GARDNER, F.S.S., F.G.S.

No substance is so superlatively fitted for monumental use as bronze; there is a sense of dignity, weight, and value about it when used in considerable masses, possessed by no other material; it defies the ravages of time, and baffles the iconoclast who would deface it. Take it all in all, it is more enduring than any other thing on earth, for, though surpassed in some of its properties by gold, silver, and platinum, the great intrinsic value of the precious metals has in all ages proved the destruction of works in which they are largely present. In contemplating great works of bronze, this vast and limitless enduring capacity of the material insensibly asserts itself, investing them with a solemnity, and awakening feelings which it must ever be the highest aim of memorials to the dead to produce. Mountain chains and coast lines of even the hardest syenites and porphyries present scenes of ruin, with aiguilles and rocky islets to mark the crumbling and disintegrating action of sun, frost, rain, or surf; but the external elements would work almost in vain on the contours of a world cast in bronze.

Bronze is an alloy of two or more metals in which copper predominates. The subject of alloys is to be treated so exhaustively by my friend Professor Roberts-Austen before the Society in a few weeks hence, that I shall not presume to allude to it now. I cannot refrain, however, from congratulating ourselves that metallurgical secrets of profound interest, and of the highest importance to us to know, should be revealed for the first time to this Society by the most competent living authority. The results, among others, of forming these alloys, is to modify the fiery red of copper through every

shade to the yellow of pale gold, or the pure white of silver. Further, age and varying exposure clothes some of them with a skin or *patina* ranging from vivid blue-green to olive, and from jet black to rusty red. This favoured metal bronze! These exquisite rusts, instead of eating into its heart like the rust of iron, cover it with an impermeable sheath, and preserve it from decay. It is almost superfluous to say that all these natural tones of colour can be imitated artificially. The Japanese excel in the art, and blend and cloud them together, enriching the palette of the worker in bronze with colours, such as coral red, which almost cease, without ceasing, to be metallic. We may also, if we please, without departing from immemorial precedent, obtain increased richness by gilding, plating, enamelling, nielloing, and damascening.

But this far from exhausts the capabilities of bronze, for in the matter of form it is even more Protean. Everything possible to the sculptor's art is possible to bronze. It can be fused and cast into moulds of every intricate shape and for every purpose. Or it may be rolled and drawn, and hammered and beaten into every kind of utensil, from the familiar copper of the kitchen to the most delicate object that the art of the goldsmith can produce. Remarkable hoards, discovered from time to time, show that bronze was all in all to our prehistoric ancestors; it served for weapons, tools, utensils, and ornament. When architecture began, it entered largely into the construction and embellishment of buildings. Art employed it for statues, candelabra, tripods, money, and medals; solemn records, laws, and treaties were engraven on it. In peace its sonorous tones record the flight of time, and summon us to worship; in war the clashing cymbals, blare of bugle, and trumpets' bray, have played no mean part. Of late we have added the "death-dealing roar" of cannon, and the life-saving croak of the siren, or fog-horn, to the voices of our useful servant, bronze or brass.

It would be interesting to track the metals, whose properties when blended are so diverse, to mother earth, and I should like to treat that subject *au fond*. To explore the "country" rock, with its loads and veins, and these with their faults, and upthrows and downthrows, "checks" and "troubles," from the stream works of the surface to the mines, so many fathoms deep, that I have boiled eggs in the water as it issued from the rock. The story of the mine is as full of mystery and romance as the story of the sea. People embark their all, either to find their capital returned one thousand times over, as in the case of the Devon Consolidated, or to see their money utterly and hopelessly sunk in barren adits and shafts. The beauty and variety of the ores of copper, as kindly exhibited to-night by Mr. Gregory, portend the lovely contrasts to be obtained from them in their manufactured state. But lovely as are these blue and green carbonates, these red and black oxides, these grey, purple, and yellow sulphides, they are without compunction mixed, and calcined, and smelted again and again, until the regulus or residue is sufficiently rich, when it is refined with carbon and run into ingots. I ought to explain the rudiments of this manufacture, if the bronze mechanism of the clock did not warn me not to linger, for we cannot really talk profitably on a subject unless we know all about it from the beginning.

Though an artificial compound, and not a natural product, the history of bronze has no beginning, and tradition is even silent as to the continent from which its use first spread over the earth. We only know that Assyrian bronzes exist which were made more than 2,000 years before the Christian era, while the Egyptians were fashioning their lintels and sarcophagi with tools of bronze in the sixth dynasty. The most ancient records of China, under the Chang dynasty, 1766 B.C., show the art of working in bronze in full perfection. Dr. John Evans says that our bronze age ceased in the fifth or fourth century B.C., but that no beginning can be assigned to it, though the perfection and complexity of the objects discovered show that the art had endured here for many centuries. If Sir John Lubbock is right, our barbarous isle was resorted to for tin by the Phœnicians 1200 or 1500 years B.C. The use of bronze came in everywhere with dawning civilisation, and immeasurably antedates alike history and tradition.

The history of bronze working as a fine art is equally lost in the remoteness of its antiquity, but the beauty of the material soon led, we can well imagine, to the ornamentation of the weapons and utensils into which it was fashioned. Perhaps the desire to distinguish one's own property, or to exalt the property and surroundings of a chieftain, may have been the humble beginning whence art sprang, but arrangements in nicks and notches formed probably its elementary stage. Figures of animals, so far as we know any-

thing about it, would seem to precede those of men; it is safe to conclude that the image bearing the name of an Assyrian king, who lived either 2,100 or 2,200 years before Christ, does not represent anywhere near the infancy of bronze, even as an art. The highest aim and accomplishment of art is the representation of the human form, for we are told God made man in his own image, and therefore man in his highest type is "the roof and crown of things," and nothing more beautiful is to be imagined. The apogee of this art about coincides with the introduction of actual portraiture in bronze, as seen in the bust of Pericles by Cresilas, shortly before the time of Phidias. The figures of Osiris of the Egyptians, and the angels of the Hebrews, were rather objects connected with religious worship than commemorative. It is recorded, however, that Romulus had his statue set up in bronze, crowned by victory, and in a chariot with four horses, while another bronze statue was erected to Horatius Cocles, an equestrian statue to Clelius, and the goods confiscated from Spurius Cassius served for a statue to Ceres. The use of bronze in Italy preceded its use in Greece, and we may well imagine its relative importance, since the guild of bronze workers stood third under Numa Pompilius. Another most suggestive item of history is the record that after the war with the Volsinii, 2,000 statues of bronze were carried to Rome. According to Pausanias, the art of statuary founding was only introduced into Greece in the 42nd Olympiad (546 B.C.), and if so, it must have spread with a speed only paralleled by the spread of railways, for the Romans found about 3,000 statues at Olympia, the same at Rhodes, also at Delphi, 3,000 remained at Athens after its first spoilation by the Romans, and, singularly enough, Mummius took the same number from Corinth to Rome. Once more, 3,000 were collected by Scaurus and used to decorate a theatre. Some of these, like the Minerva of Phidias, 70 feet high, crowning the Acropolis, and made from the spoils of Marathon, or the Jupiter of Tarentum by Lysippus, 60 feet high, were colossal. An Apollo taken from the Samnites, and set up in Rome, could be seen from the Alban hills, and the statue of Nero was 115 feet high. All these were bronze, like the still more famous Colossus of Rhodes, which was 105 feet high, and weighed 720,900 pounds. Only one of the gigantic antique bronze statues has escaped destruction, that of Theodosius at Bartella. We must quit the subject, however. In reading this paper, I am obliged to pass over section after section of our subject until only a small sub-section of it is left. Suffice it to say that the originals of almost all the finest antique marble statuary preserved, are known, or believed to have been, in bronze. The immense value of the material in the days when they were smashing and reducing marble statuary to the mutilated condition in which we are but too glad to recover it, led to the almost complete disappearance of large objects in bronze, but we have the Sleeping Fawn of Herculaneum, the Wrestlers of Portici, the Boy with the Thorn of Pompeii, the Hercules of the Capitol, the Septimus Severus of the Barberini Palace, and the colossal equestrian Marcus Aurelius, which was spared, as it was believed, to represent a Christian emperor. Of small statues the quantity discovered is innumerable.

There is one point connected with antique statuary that we cannot pass over, and that is its colour and treatment, for this is suggestive of endless future possibilities. It is doubtful whether the metal was stained or allowed to oxidise at all, and whether it was not assimilated as much as possible to the colour of the sunburnt athletes it represented. We still speak of being bronzed by the sun, and this, like many another familiar expression, may have been handed down from remote times. Plutarch mentions a dying Jocasta to which a mortal pallor was given by a silvery bronze, and Pliny a bronze, Athamas, red with shame. Callistratus records that Praxiteles gave a natural colour to bronze statues of Cupid and Bacchus, and a bas-relief, representing a battle between Porus and Alexander, is said to have equalled painting in the brilliancy of its colours. A life-like expression was given by glass or marble eyes, and sometimes head-dresses, &c., were in gold and silver. The statue of Hercules, found recently in Rome and now in the Vatican, was gilt, but probably gilding belongs to a late period, when art was in its decadence. The present appearance, which we admire in Greek and Roman bronze statuary, is due to the conversion of the surface copper into carbonate by contact with carbonic acid contained in rain water, particularly when it has percolated through volcanic ash. The commonest colour is green, but blue, light blueish green, and red are also met with. I wish I could introduce some most valuable remarks sent me by my friend Dr. Johnston Lavis, of Naples, as to how these have, in some cases, been coated with malachite, in

others by bright blue azurite, or the chalky blueish aurichalcite, and the red crystalline cuprite. The smooth, hard, dark, polished surface more characteristic of Herculaneum bronzes, is due to their having been enveloped in a compact and impermeable matrix.

We now have to pass over subjects wholesale. The panelling, and even paving, of Greek and Etruscan tombs and treasuries with bronze; the bronze produced under the influence of Byzantine art, including the huge bronze church doors, about 200 examples of which still exist in Italy; the whole subject of bronzes of the Renaissance, rendered so illustrious by Andrea Pisano, Donatello, Ghiberti, Verrochio, and Cellini. These, as well as Flemish, German, and French bronzes, were ably, but all too briefly, treated by my friend, George H. Birch, in his Cantor lectures, of which I have made the freest use. Having set aside branches of our subject, enough for several separate papers—for everything in bronze by which the memory of a person or event is perpetuated is a monument—we come to the only section which time at all permits us to deal with, the use of bronze for sepulchral monuments or tombs. These are mainly of two kinds, those in relief, and the flat, incised slabs, called brasses. In England we have not more than a dozen of the former and about 4,000 of the latter still preserved. The most important of the bronze tombs in relief are in Westminster Abbey, and we will rapidly pass them in review.

The earliest is that of Queen Eleanor, who died *en route* to Scotland in 1290, when her body was embalmed with spices. As appears customary in those days, the heart was buried separately in the church of the Friars Predicants in London, and the bowels interred at Lincoln, under a brass effigy similar to that at Westminster. The effigy, in gilt bronze, is in simple attire, falling in not ungraceful folds, while the expression is one of sweetness and composure. An unjewelled crown is worn, but the cushion and slab are diapered all over with the arms of Castille and Leon. The small canopy above the head has a scaled roof and well-modelled angel head corbels, and there are at the feet two lions. A part of the inscription is visible, "Ici gist Alianor jadis Reyne de Engletere: femme al rey Edeward fiz—."

The effigy of Henry III. is similar, but much stiffer, and the lions and canopy have disappeared. It rests too high up to see the details, but the head is said to have much of the simple majesty of the Greek school. The heart is buried at Fontrevault. The feet and cushions are diapered all over with lions. Henry died in 1272, and his is the earliest bronze effigy in England.

On the south side is Richard II. and his queen, in more sumptuous robes, embroidered with rising runs, white harts, and peas-cods, with jewelled hem. These, like all the other royal effigies, rest on a slab cased in brass, with chamfered edges, on which inscriptions are engraved; holes indicate that some ornament had been removed. It is difficult to see the queen. The canopy is double and still rich, though much has been stolen; the face is evidently a fine portrait, though somewhat coarse, and no longer representing a beautiful and ingenuous countenance. It bears a small forked beard. The head is uncrowned, with the hair bound by a fillet; the feet are almost hidden by drapery. All the figures of saints and angels, the enamel shields, the hands, the two lions, eagle and leopard on which the feet rested, in fact everything portable, has been purloined. The bronze work, made during the king's life, 1395-7, cost £400.

Next this is the tomb of Edward III., died 1377, which has suffered far less spoliation. On each side of the effigy is some architectural metal work, supporting a richly wrought canopy, in the niches of which are angels, cast from one mould, while other enrichments have evidently disappeared. The figure is tall and thin, the head bare, with long flowing hair and beard parted down the middle, and moustache. The features give little indication of the heroism displayed at Cressy. The garments are plain, with engraved jewel-pattern borders; plate armour peeps from beneath the sleeves, and covers the wrists. The shoes are thin, pointed, and embroidered, right and left hand, and formerly rested on a lion. A band crosses the breast, and sustains the mantle, but there is otherwis no jewellery, and the neck is bare. All the small bronze figures and shields on the north side of the tomb have been removed, but on the south side the six figures, about 15 inches high, remain. They are indifferently executed, and represent four sons and two daughters of the king. Four small and beautifully enamelled shields remain, showing that the red, which apparently cannot now be produced, presented no difficulty then. There are four large shields below, also enamelled, two with the arms of England, and two with red cross on a gold field.

In St. Edmund's Chapel we have a monument of great value, for it is, with one exception, the only existing specimen of the beautiful enamelled tombs of Limoges; the other being now in the Louvre. The effigy represents William de Vallance, Earl of Pembroke, half-brother to Henry III., and is a work of art formed of copper plates beaten over a core of oak. The body is in gilded chain mail and surcoat; the face, calm and handsome, if inexpressive, looks from a mailed hood with a jewelled fillet. The shield, belt, slab, cushion, &c., are richly enamelled, and the tomb must, when complete with its enamelled sides and gilded figures and shields, have been a most gorgeous object. The Earl died at Bayonne in 1296, so that the effigy is almost contemporaneous with that of Queen Eleanor. A similar tomb to Sir Walter de Merton, at Rochester, cost £41 5s. 6d., but has long since disappeared.

Of the same date almost as the monument of Edward III. is a bronze of absorbing interest, the effigy of the Black Prince at Canterbury. Unlike the regal effigies of Westminster, the warrior prince is represented in a complete suit of gilded mail and plate armour, with short heraldic surcoat; all armed in steel for battle, as directed in his will. The figure is splendidly modelled and cast, and full of dignity and repose. The head is enveloped in the *camail*, with long moustache and beard tucked in, and it is pillowed on the fighting helmet, surmounted by a gigantic lion crest, an original of which, as well as of the gauntlets on the hands, is suspended above. The head wears the pointed bassinet, with an encircling jewelled crown, which, like the large rowelled spurs, the sword girdle, &c., is richly enamelled. The body reposes on a metal table, with deep chamfered edges to receive the inscription, and on the sides of the tomb are finely enamelled shields. The whole is in most perfect preservation, and we are most fortunate indeed in being able to look on the actual personation of this splendidly historical figure, armed no doubt as he actually was on the memorable occasions of Cressy and Poictiers. He died in 1376.

Another sumptuous gilded bronze effigy of a warrior in full armour is that of Richard Beauchamp, Earl of Warwick, Governor of the Kingdom of France and Duchy of Normandy, under Henry VI., in the Beauchamp Chapel at Warwick. He died 1439. The head wears a coronet, but no helmet, and like that of the Black Prince. rests upon the great crested *heaume*. The fashion of armour had completely changed in this interval, and we see chain mail discarded. The feet rest against a sitting bear and griffin; the figure is loose, and as beautifully finished underneath as above. The most salient and ornamental feature of the tomb is the permanent brass herse which protects it; for these are generally temporary structures set over the coffin while it lay in state, to receive the pall and hold the indispensable wax lights. There are gilt images of mourners and angels, as well as enamelled shields, on the sides, and though not beyond criticism as a work of art, the tomb is most magnificent, and the metal work is as perfect as on the day of its erection.

The massive gates which close in Henry VII.'s chapel are the only examples of this application of bronze in the country in olden times. They are formed of massive plates of cast and gilt metal fastened to an oak frame. The design is panelled, the centres containing the oft-repeated royal badges of Henry VII. and his predecessor in open cast work. The plates are bolted to the wood by rivets, the heads of which form smaller badges, such as knots and dragons, with larger roses at the intersections. The centre gates measure about 8 ft. over, and have sixty-two panels. The side gates repeat the same design on a smaller scale. The lock-plates are very beautiful, and have been engraved, but the centre and two of the side ones are missing. Bronze gates or doors were favourite works in Italy, and enormous sums were lavished on them.

The screen round the tomb of Henry VII. is of great magnificence, and though massive and rich in the extreme, it does not look clumsy. At each angle there is a large octagonal open-work column filled in with diapering, and there are in all thirty-two niches for saints, all but six of which have been stolen. The sides are divided into two tiers of traceried panels, divided by an inscription horizontally, and vertically by slender open-work buttresses. The portcullis and the dragon and greyhound occur in the panels. There is an overhanging frieze, arched and groined beneath, of quatrefoils with roses and the portcullis, and above this again there was a handsome open-work coping, nearly all of which has disappeared, together with a good deal of work from the inside. The doors, surmounted by the royal shield and supporters, are further emphasised by a projecting bracket

supporting the crown of England resting on an upturned Tudor rose. These remind one of Italian cressets, and doubtless held a light of some kind. The drawing exhibited is from a large and beautiful engraving by Hollar, belonging to my father, unique I believe, which shows the grille in its perfect state. The pilfering of so much of the metal work from the Abbey tombs that was at all portable was not the result of fanaticism, but of simple theft carried on with impunity down to our own times.

There is a very handsome but rather heavy looking bronze railing round the tomb of the Earl of Worcester in St. George's Chapel (1526), Windsor, which replaces the old one, plundered in the Civil Wars. I know of nothing similar in England.

So far, the metal work described, except the Limoges tomb, has been of English make. The tomb of Henry VII. and his queen, inside the grille, is the work of an Italian—Torregiano, who having broken Michael Angelo's nose with his fist, found it expedient to accept an invitation to work for those "brutes of English," as he subsequently described us to Cellini, his friend. It is inconvenient to study the effigies through the grille, and it is a pity that casts are not in the Kensington Museum, for they are splendid specimens of Italian Renaissance art. There is a sublime simplicity about the figures of the king and queen, who are enveloped from head to foot in a plain mantle, without jewellery of any sort, and with the hands raised in prayer. The venerable, and rather emaciated, features of the king appear below a head-dress something like a modern travelling cap, with ear-flaps; and a simple hood forms the head-dress of the queen. The faces are exquisitely modelled, and must be truthful portraits. The black and white marble is almost concealed by the rich metal decorations, the chief features of which are large medallions, each containing two patron saints, in high relief, with rich pilasters between. Angels sit at the corners, but in spite of the protective grille, the emblems they held, and even two of the wings, and the coronets of the king and queen, have been stolen.

The tomb of the venerable Margaret Beaufort, mother of Henry VII., is also the work of Torregiano, and equally beautiful as a work of art. The hooded effigy is in the attitude of prayer, and exhibits a face of much goodness and dignity. The drapery of all the older effigies has been modelled as if the figures were upstanding, but here the folds are natural to the recumbent position. The pillows on which the head rests are superbly worked, and above it is a peculiarly flat, open-work canopy, whilst alongside the body are open buttresses. The rest of the tomb is in black marble, except the gilt shields in the centres of the panels, and the inscription which borders the edge of the slab.

Torregiano was also commissioned by Wolsey to make a sumptuous monument, and it appears that 4,250 ducats had been expended, besides £300 for gilding, when his disgrace ended the work. The black marble sarcophagus is in St. Paul's, and contains the body of Nelson. Poor Torregiano went to Spain, and was burned by the Inquisition for smashing a figure of the Virgin, which was insufficiently paid. At this moment we appear to have been very near to establishing a bronze industry in England, when the services of Cellini and others would probably have been secured to us instead of to France; but the Reformation completely upset all hope of this, and drove away the foreign artists that had already been attracted. Again, under Charles I., there was a great possibility of our becoming an art country, on a level with continental nations, but the scarcely risen sun of art was once more drowned in a sea of religious and political strife, and so effectually indeed that it has only now begun to peep up again.

There are but two more bronze tombs to mention in the Abbey, both of them in Henry VII.'s chapel; both ambitious, but just missing the sublime. They illustrate the strong feeling for art which was growing up under the influence of Charles I.

The tomb of Villiers, assassinated by Felton in 1628, is the more pretentious. The duke and duchess repose in state, the former in highly enriched plate armour and an ermine cloak, and the latter in robes. The duke wears his orders and both are coronetted. A vast number of figures emblematic of the duke's fame and virtues surround them. At the feet is a figure of Fame blowing a trumpet; by their sides, plunged in grief, are life-size bronzes of Mars, Neptune, Pallas, and Benevolence. Above are several figures in white marble, and some gilt bronze decorations. At the angles are black marble obelisks, once decorated with gilt metal, and still resting on gilt skulls. The bronze work of the tomb is very good, and without the lofty and over-enriched back and the figure of Fame it would have been admirable.

The second monument is to the Duke and

Duchess of Richmond and Lennox, who died 1624. In the centre is a handsome sarcophagus of black marble. At each angle is a fine figure of Faith, Hope, Charity, and Prudence, performing the office of Caryatides, and supporting a baldachino, consisting of marble entablature, and pierced bronzed dome-shaped canopy, surmounted by Fame. On the sarcophagus are the effigies of the duke and duchess clasping hands, and richly attired. The duke is in magnificent embossed plate armour, mantle, collar of the garter, ruff, and coronet. The entire monument is sumptuous, very suggestive, and, except the figure of Fame, is a fine work of art. It shows that the canopied form of tomb in metal has very great capabilities, particularly in the open.

We now come to the flat incised metal monuments known as brasses. I have scarcely felt competent to deal with these, and my friend Mr. F. A. Walters, F.S.A., has kindly helped me out of the difficulty, and to his accomplished pen the following all too brief account of them is due. To him and to Mr. John Codd we are indebted for the fine display of rubbings which admirably illustrate our subject.

"A most interesting branch of artistic metal industry, during the middle ages and later, was the engraving of memorials to the dead on sheets of the metal now known as brass, but then termed "latten." This metal, known in ancient times as oricalchum, was composed of calamine (carbonate of zinc) calcined, and mixed with less than two-thirds of its weight of bean-shot copper, melted in crucibles. The earliest record of its manufacture in England occurs in sundry patents, granted for the purpose by Queen Elizabeth in 1565 to some Germans. Previous to this time it was imported into this country from Flanders and Germany, under the name of "cullen plate," from Cologne, the chief place of its manufacture.

"The earlier monuments of brass, first found in the 12th century, are in low relief, and with those engraved and enamelled, after the manner of the well-known work of Limoges, formed the connecting link between the arts of the sculptor and enameller and that of the later engraver.

"Engraved memorial brasses probably originated in Germany, and the earliest existing example now to be found is at Verden, in Hanover, dated 1231. There are, however, recorded examples of earlier date, even in England, one as early as 1208 being said to have existed at Bedford. At present we have no specimen older than 1277, the date of the fine brass of Sir John d'Abernoun, in the church of Stoke d'Abernoun, Surrey. After this period we find these memorials in ever increasing numbers, down to the early part of the 16th century, when they became less frequent, and ceased altogether about the time of Charles I.

"Although the sheets of metal came from abroad, brasses appear to have been much more largely employed here than on the Continent, for while, notwithstanding the wholesale destruction during the troubled times of the 16th and 17th centuries, and their neglect since, we have still over 4,000 known examples remaining; over the whole Continent of Europe their number is said not to exceed 200 at the present time, although, as with us, they were formerly much more numerous, very many having been lost or destroyed, especially during the French revolutionary period. The brasses in England are evidently the work of native artists, their characteristics being quite distinct from those on the Continent. The few fine examples that we possess of brasses of foreign make serve to bring this out very clearly.

"The special distinction of English brasses is that the figures, canopies, and other parts of the design, were all cut out of the sheets of metal, and let into slabs of hard stone or marble, which then formed their background, leaving the design clear and distinct in all its parts. The foreign examples, on the contrary, have the whole design engraved on rectangular sheets of metal, every portion of which is covered, the backgrounds to the figures usually having richly engraved diaper work in lieu of the plain stone surface of our own specimens.

"The latter part of the 14th century saw the rise of a splendid school of continental brass engravers, probably Flemish, whose works, many evidently by the same hands, are now to be found scattered over the whole of northern Europe. The noble brass of Abbot Delamere at St. Alban's—one of the few foreign brasses in England—is a typical example of this school, being in many of its details identical with those of about the same date at Lubeck, Schwerin, and Stralsund, in North Germany, and Thorn in Prussian Poland, showing how widely extended was their reputation.

"In England, towards the close of the 15th century, the art displayed on monumental brasses began to decline in a marked degree,

many after this period being of very rude execution. This does not appear to be the case with the Flemish and German examples. The Flemish brass of Andrew Eryngar (1536), merchant of London and Antwerp, in the Church of All Hallows, Barking, is decidedly superior to most English brasses of the same date, while the magnificent brass, dated 1510, in the Cathedral of Cracow, is not surpassed, if equalled, as regards the figure, by any earlier example.

"Before concluding, it may be remarked how suitable is this kind of memorial in churches of the present day, especially if made mural, as has been done with most of the continental brasses. They occupy no space, they may form pleasing and appropriate decorative features, and their cost can be very moderate, while they remain totally uninjured by the hand of time, thus forming the most lasting of all monuments. Those that remain to us from previous years are most valuable records in matters of history, costume, and heraldry; while in recent years the claim to an ancient peerage was established on the evidence furnished by a monumental brass of the 15th century." So far Mr. Walters writes.

France was probably much richer in metal tombs than England, for Limoges was from the earliest times a seat of manufacture, and the art has never ceased to be encouraged from the time when Cellini was invited to take up his abode in Paris, till the present day. The Revolution swept away these memories of the past by wholesale, for works in bronze were eagerly sought to melt into money or cannon, of which the French soon stood in sore need.

Mr. Birch has described the Limoges bronze of Blanche de Champagne, 1283, in the Louvre, the only specimen of the art, except our own, of De Valence, which has escaped destruction; and also the two bronze bishops of Amiens, each supported on six lions, 1220-37, earlier in date than any bronze monument in England. With the outbreak of the Revolution, a descriptive account was fortunately commenced of the monumental antiquities of France ("Antiquites Nationales ou Recueil de Monu-

FIG. 1.—FIGURES FROM TOMB OF DE LANNOY.

mens," by Millin), which conveys some idea of what was destroyed. In the Collegiate Church of St. Pierre, at Lille, some of great interest stood. That of Hugues de Lannoy and his

FIG. 2.—SIDE VIEW OF THE TOMB OF DE LANNOY.

dame, 1456, recalls the Warwick tomb, showing a similarly armed knight, bareheaded, and without gauntlets, and with surcoat embroidered with the arms of Flanders. The artist has given both a severe expression. A still more sumptuous tomb was that of Louis

de Masle, Count of Flanders, who succeeded his father in 1346, almost immediately after the battle of Cressy, where he was wounded. He was forced by his subjects of Ghent to affiance himself to Isabel of England, but escaped and married Marguerite of Brabant, whose effigy, with that of their daughter, Duchess of Burgundy, reposed beside his own. During one of the desperate *émeutes* at Ghent he barely escaped by hiding himself in the children's bed of a poor woman's cabin; and after a stormy reign he died before the expiration of a year's truce, imposed on him by the English. The monument was erected by the Duke of Burgundy in 1455, and represents the count in rich armour, except the hands and feet, while the head wears a hat with upturned brim and jewelled front. The face is full of character, with fine expression, short, pointed beard, moustache, and wavy hair. Sword and *miséricorde* are worn, and on shield and breast are the Lion of Flanders. The ladies are chiefly remarkable for their *coiffures* and many-buttoned sleeves. Two angels, with wings extended high, kneel at the head, and between them is the great *heaume*, surmounted by a crown and crest. Round the tomb are 24

FIG. 3.—TOMB OF LOUIS DE MASLE, COUNT OF FLANDERS.

figures of Princes and Princesses of Flanders and Burgundy, which are most exquisitely modelled, and an epitome of the costume of the nobles of the period. The whole was ruthlessly consigned to the melting-pot, in spite of its interest and beauty.

The Westminster Abbey of France was St. Denis, which must once have far surpassed our own places of royal sepulture in the number of its bronzes. We may instance the famous tomb of Charles le Chauve, of the 12th century, the great doors of the cathedral, and the Mausoleum of Barbazan, 1432.

But perhaps as rich was the Church of the Célestins, now destroyed. Successive kings emulated each other in their gifts and endowments, and it contained a vast number of celebrated monuments. We will only stop to notice some of those which were receptacles of hearts, and not of the entire bodies of the dead. It was the practice, as we have seen in the case of Queen Eleanor, to bury the heart separately, but we have very few of the monuments left in this country which contained them. In the southern chapel of Henry the Seventh's Chapel is an obelisk of black

marble, surmounted by an urn, containing the heart of Esme Stuart, 1611. They generally took a pyramidal form, and some were of great beauty, and might well serve as models in cases of cremation. One of the finest was fortunately secured, and deposited in the Louvre. The pedestal is ornamented with acanthus leaves, lions' paws, rams' heads and Cupids, and on it stand three draped Graces, considered the *chef d'œuvre* of Germain Pilon. A bronze urn is supported between them, which contained the hearts of Henri II., the Duc d'Anjou, and Charles IX. of evil memory. The monument was made for Catherine de Médicis, and we fortunately possess a cast of it in the Kensington Museum. In the same Orléans Chapel of the Célestins stood a white marble column, with three children holding torches at its base on a porphyry stand. On the summit is a bronze urn, upon which a

Fig. 4.—Bronze Urns from the Chapel of the Celestins.

graceful Cupid is in the act of placing a crown. It contains the heart of François II., who died in 1560, at the age of 17, after a reign of only seventeen months. Another splendid tomb, of the same class (by Barthélemi Prieur), contains the heart of the great Anne de Montmorenci, created Constable of France in 1538. The column is twisted and ornamented with foliage and flutings, with composite capital and bronze urn. The pedestal is of marble, accompanied by three bronze statues of the Virtues bearing insignia. Montmorenci was illiterate and avaricious, and seems always to have been beaten or taken prisoner in his battles. He behaved with great brutality in entering Bordeaux, though the town was surrendered, hanging one person for every ten houses. On another occasion he committed an action like that which covered Colonel Kirk with infamy. He was killed at the battle of St. Denis by a

Stuart, and buried with regal pomp. Another monument in the same church, to Timoléon de Cossé, is of somewhat similar character.

Flanders was also rich in sepulchral bronzes. We can only notice the celebrated tomb of Mary of Burgundy, wife of Maximilian, constructed 1495—1501, and the slightly inferior but very similar tomb of her father, Charles the Bold of Burgundy, which was not executed till 1558. The tombs are black marble sarcophaga, on which repose the life-sized effigies in gilt bronze, the tomb of the empress being by far the finer of the two, and was formerly covered by a herse of forged iron, designed by the painter, Jean d'Hervy. The richest heiress in Europe, the sides of the tomb are filled with enamelled shields with the arms of the duchies, counties, and estates which she brought to the House of Austria. Pierre de Beckere became paralysed, and lost many workmen, from the effect of the mercury in gilding this tomb. Her death was through a fall from her horse while hunting near Bruges. The tomb of the husband of this princess at Innsbruck (1582), is, without any question, the most sumptuous monument of bronze in the world. The figure of the emperor, crowned and in his robes, is kneeling on a lofty marble pedestal, at the angles of which are superbly modelled female figures. Beneath are the celebrated white marble panels, representing events in the life of Maximilian, and around is a most elaborate grille of the type peculiar to Germany in the 16th century. Round this magnificent tomb stand twenty-eight figures of heroic size in massive dark bronze. They comprise, besides members of the Hapsburgh family, a number of historical personages, among them King Arthur, Theodoric, and Godfrey de Bouillon. Many of the figures are by Vischer, of Nuremberg, and it is said that they were seventy years in hand. The costumes are of the highest interest, and while the pose of many of these kings and warriors, with their dames of high degree, is not without grace; the majority of them are in a sturdy attitude befitting powerful Teutons. In a side chapel are twenty-three statuettes, cast at Augsburg by Geoffrey Löffler, 1508, destined apparently for a bronze grille never carried out. The large figures have a startling and almost awe-inspiring effect, especially if seen for the first time by a waning light.

The second most celebrated tomb of bronze in Germany is, undoubtedly, that of Saint Sebaldus, in Nuremberg. Of totally different style, it is impossible to convey any adequate description of it in words, but its general form is a richly canopied shrine, with figures of the Twelve Apostles on the supports, and innumerable smaller figures and enrichments wherever there is room to place them. Though of Gothic outline, there is fine Renaissance feeling in the detail, as might be anticipated in the *chef-d'œuvre* of Peter Vischer. The shrine itself is a chest of silver and gilt *repoussé* work, chequered all over with the Imperial arms, and its pedestal is paneled in bas-reliefs representing the life of the saint. The whole, canopy and all, rests on a bronze slab supported on snails, which appear to be slowly and irresistibly bearing it forward. Noticeable features are the mermaids, holding sconces at the angles, and the figure of the artist at one end. It weighs eight tons, and was made 1508-1519, and a cast of it is in the Kensington Museum. Germany abounds in bronze tombs, and we possess casts of those of Canon de Veltheim, Hildesheim, 16th century; Lucas Cranach Weimar, 16th century; Presbyter Bund, Hildesheim, 13th century; Otto IV. by Vischer, Thuringia, Count and Countess Weinnberg Munich, Count Hennenburg, &c. Other fine bronze tombs are at Aschaffenburg, Wittenburg, Magdeburg, Cologne, Coburg, Cassel, Bamberg, &c. In Germany there are also bronze tombs in low relief, a type unknown elsewhere, numerous examples of which occur at Bamberg, Marburg, Breslau, &c. These pass almost insensibly into brasses, which occasionally have the features raised in relief.

We must, unfortunately, for want of time, wholly pass over the bronze tombs of Italy, though many popes are commemorated in bronze in St. Peter's, and tombs of the finest character abound everywhere in that country. There are also a few in Spain, like that of Juan II. at Burgos.

The various methods of producing these works of bronze and brass is by no means the least interesting section of the subject. One, very often practised in antiquity, was to beat metal plates over a core of wood or other material, and rivet or solder them together. We have seen an example of this work in the De Valence tomb. The last time it was practised in Europe was probably in the Carlo Borommeo statue at Arona. Objects in the Chinese Court at Kensington show both methods. This was succeeded by casting figures piecemeal, and burning the pieces together, all Greek cast statues being produced more or less in this way. Lastly, figures were cast at once, *d'un seul jet*. Originally,

perhaps, and certainly during the Renaissance, the *Cire perdue* process was adopted. This was so fully described by Mr. Simonds in the *Journal* for February 5, 1886, that it is quite needless to recapitulate it. The process is delicate, long, and risky for large objects, and the original is every time destroyed, so that piece-moulding in sand is preferred commercially. It is entirely erroneous to suppose that the art has ever been lost, for the group of gladiators by Gérome, so much admired in the Trocadéro, was produced by it. A full and most interesting account is preserved of the casting of the great equestrian statue of Louis XIV. by it in one jet. Piece-moulding in loamy sand leaves certain seams, which necessitate chasing the casting to a greater or less extent. Artists differ as to whether bronze should be chased. My own opinion is that a mere *fac simile* in bronze of the wax is opposed to the nature of the metal, and looks plastic as gutta-percha. In France the art of chasing has arrived at such perfection that the artist can safely entrust his work to professional hands, feeling sure that the surface will merely be caressed and smoothed from roughness and imperfections. Natural objects can be pressed into sand, calcined, and the ashes blown out. Barbédienne, in Paris, produced sprays of leaves, crayfish, &c., in this manner, and the Japanese appear to resort to it. I have one or two small fish left that I had cast some years since. The small object kindly exhibited by my friend Mr. Purdon Clarke, has been described by him to the Iron and Steel Institute. In the larger half of the gourd-shaped object is a bronze chain-pattern bracelet, just as cast. The links were modelled in wax, which was covered by thin coatings of red clay, until at last a thick coating, such as you see, is produced. The smaller chamber of the gourd is filled with metal, and placed in a primitive furnace. The wax melts, and escapes through a small vent, and after a time the metal, too, melts, and takes the place of the wax. This is the *cire-perdue* process in its simplest form. Messrs. Elkington have produced statuettes, and even small statues, by electrotyping.

The hasty and imperfect glimpse we have taken of some existing bronze tombs by no means conveys an adequate idea of the capabilities of the material for even this purpose alone. In the cemetery of St. John, Nuremberg, some 3,000 gravestones of bronze have been placed, from the 15th century down to the present day, the oldest of which are indistinguishable, as to colour and preservation, from the new. A cast of that to Albert Dürer is at Kensington. The fine modelling of the arms and mantles, and the rich colouring of the bronze, produce an impressive effect, and whether we take a cursory survey, or linger to decipher and study, the feeling of reverence abides. Above all, the display of weakness and vanity—that string so successfully played on by the undertaker—is nowhere discernible. In our cemeteries we are somehow made to feel that Smith was richer than Jones. They are cities without plan, buildings without architects—a vast aggregation of tasteless, stock-pattern monuments, souring down on each other on every side, until the whole expanse becomes a forest of broken columns, urns, and obelisks—a wilderness paved with stones, on which vast sums have been uselessly sunk. Fortunately, our urban and suburban cemeteries have but an ephemeral existence, and the ponderous slabs which we have piled on the dead as if there were to be no "Resurrection of the Body," are spirited away, and give place to flowers and shrubs. If the exact burial spots had been simply marked, and the stones to perpetuate the memory of the dead contributed on some fixed plan, what splendid and lasting mortuary piles might have been raised, eclipsing the *Campo santos* and colonnaded cemeteries of Italy.

It is difficult to believe, however, that our respect and affection for the dead is not more fittingly expressed by the erection of some memorial of use to mankind, and I fear it is too often overlooked that a monument is not necessarily a building, statue, or tombstone. Anything by which the memory of a person or an event is perpetuated is a monument, and not the least beautiful and appropriate of those that have been handed down are windows, screens and fonts. Pure objects of art, especially if they recall the memory of noble qualities, exert an indefinable influence for good on mankind, and the wisdom that guides our gracious Queen is better exemplified in nothing than in the magnificent patronage she has afforded the sculptors' art in commemorating her lamented consort. The sculptors' art, indeed, lives but to commemorate the past, but there are persons of average wealth daily desiring to record the losses that death occasions every hour, to whom the price of sculpture is prohibitory. If we could but divert this perpetual golden shower from the undertakers' catalogue, the art of the metal worker would need no other patronage, for works in

bronze and brass, from their imperishable nature, must ever satisfy this sentiment in the highest degree. The trumpery fittings of our churches would soon be replaced by lecterns, fonts, rails, standards, and coronæ, for even a simple bracket could be made most amply to satisfy the mind, if art predominated in it. Such memorials need be neither elaborate nor costly, but each one must be designed for its purpose and the position it is to occupy, for the sentiment and the encouragement to art at once disappear if they are chosen from catalogues of stereotyped forms. In all cases obtain, in the first place, the advice of an architect or artist.

Even more ambitious forms of monument for our public places are within the reach of many if they did but know it. I could give an instance where a thoroughly satisfactory work of art is now erecting at a cost less than I have known to be paid for a simple brick and granite grave. We are really not limited to statues, a commission for which seems to paralyze the art in even our best sculptors. Our great ones may tower head and shoulders above their fellows in worth and intellect, but in feature and physique, especially when clad in coat and trouser, they cut a poor figure in bronze, and it is plain the artist models them for money, and not love. The diploma groups in bronze belonging to the Royal Academy show of what our English sculptors would be capable if allowed to commemorate people's deeds ideally. Unlike the French, we erect little to the heroes of the past. The appearance of Drake, Frobisher, Raleigh, and hosts of other grand figures in history are nnknown to us by any monuments. We have no representation of the most graceful animal, the horse, apart from its rider; nor of the dog, though it save our life or win us thousands; nor the bull, the incarnation of force and courage; nor the eagle, stork, nor of any one of God's creatures, be it never so admirable. Yet we admire the horses of St. Mark's, the Marly horses, the Farnese bull and boar, the storks and eagles of Japan.

Reproductions from the antique could be set up in bronze in our parks or gardens for little more than £100, and original vases, fountains, lamp-posts for £100 or £200. The parks and gardens of France, such as the Tuileries, Marly, Versailles, St. Cloud, abound in vases, statues, and groups. A thick volume is required to illustrate the fountains of the streets of Paris alone. The magnificent bronze column of July, over 150 feet high, and weighing 179,500 kilogrammes, or the scarcely less lofty bronze column of the Place Vendôme, with its 260 metres of bas-relief, are wholly unrivalled monuments. Ever since the days of Cellini and Primaticcio, the most lavish patronage has been bestowed on the artist in bronze in France. The splendid gilt bronzes of Versailles were produced by the State at the Gobelins; the bronzes for the Tuileries, &c., were produced at the State *Fonderies de l'Arsenal*; and works in bronze, costing many thousands, are still produced at the State Porcelain Factory of Sèvres. As a result, the bronze industry of France has amounted to 80,000,000 francs yearly, of which a million sterling was for export. Every French bourgois home possessed its elegant *garniture de cheminée*, its lamps, and girandoles, in good taste, its bronzes, or no less artistic *zinc d'art* of home manufacture, its waxed oak floor and Persian rugs, while we wallowed in the hideous Birmingham "gaselier," staring wall papers, and vulgar carpets. We are only now taking a place in matters of art manufacture among nations, but when will one of our manufacturers be rewarded with a commission like that of £10,000 for a clock for the Hotel de Ville, or for the gigantic candelabra and lustres for the Opera; for the bronzes which furnish the Hermitage, Kremlin, and cathedral of St. Isaac, in Russia, or the damascened tomb, by Zoloaga, for General Prim, in Spain. We in England push our way without State aid, and such works of art as our Government do require from manufacturers is made rather a matter of lowest price than an encouragement to the deserving. Nevertheless, with a little more public appreciation, our metal workers will not perhaps be found altogether lagging in the race; while our schools of art are certainly furnishing us with such a body of artists that the manufacturer will have little excuse for sticking in the old ruts.

DISCUSSION.

Mr. E. C. Robins said all must agree that they had had an expositon of this subject which was quite unique, the photographs, especially, being remarkably interesting; and Mr. Gardner had mingled his practical knowledge of metal-working with his archælogical information in an extremely interesting and instructive manner. As an architect, he took great interest in these matters, and in his younger days had made rubbings of monumental brasses, but he felt much indebted to Mr. Gardner

for having given such a continuous history of these things, and enabled anyone to understand how the art grew from one stage to another. He had also given examples by which they could pretty well understand the great distinction, and mark the difference, between foreign and English work, and had demonstrated those points which were most necessary to remember in the way in which it was executed. He only regretted that Mr. Gardner had not had time to deal with the bronzes of Italy, which would have been extremely interesting.

Mr. E. J. TARVER said, a few years ago he had occasion to compile a chronological list of the monuments in Westminster Abbey, and came across one of Sir Thomas Richardson. When reading a paper on the subject, at the Institute of Architects, Mr. Weatherley, who had produced, probably, the finest and most complete work on the subject of monuments, pointed out that this monument of Richardson was of bronze, and by Hubert Le Sueur, in 1635. Mr. Weatherley also alluded to portions of the Cottington Monument, in the same abbey, being of metal. There would be, therefore, others to add to the list which had been given.

Mr. SOMERS-CLARKE, referring to the beautiful photograph of the monument of Queen Eleanor, said that some years ago this monument had become perfectly black, and was cleaned with some chemical. In doing so the whole monument was lifted up, and the back of it was found to be perfectly flat, and apparently, therefore, it was a solid mass. On the back was a charming sketch of a figure, about two feet in height, with the characteristic drapery of the period. That rather led to the supposition that the whole figure must have been moulded as a solid mass in wax, and that this was melted out from the matrix of sand in which it was cast. The extreme cleverness with which the drawing was made—evidently on a soft substance, with some pointed instrument like a sharp stick—showed the skill of the hand that had done it. He did not know whether Mr. Gardner thought it probable that the figures of that date were modelled as a solid mass of wax, but if it were not so, it was difficult to see why the figures should be indicated on the flat part of the back as it was. There was certainly no joint in the figure anywhere.

The CHAIRMAN remarked that it would be easy to tell by the weight whether it was a solid mass of bronze or no.

Mr. SPARKES said it was very remarkable how extremely rare were copper implements, and as Mr. Gardner had given a history of the early use of bronze, he should be glad to know whether he could throw any light on that dark subject. The copper instruments known to museums might almost be counted on the fingers, whereas bronze instruments seemed innumerable, and every day more were coming to light. The plains of Poland, of Silesia, the hills of Mecklenburg, and the whole of the southern shores of the Baltic, seemed to yield any quantity of the most beautiful things of this character, but copper instruments were exceedingly rare. And it seemed remarkable that the metal which was the alloy, and not a natural metal, should have been discovered almost at the same time as the original materials of which it was made was found. He should be glad if Mr. Gardner could suggest any feasible theory to account for this fact. He was very familiar with the tomb of Maximilian at Innspruck, and could bear out Mr. Gardner's impressions as to the weirdness of the effect produced by those great sturdy figures. But recent researches had made it quite clear that the superior beauty of the two best figures—Arthur of England and Theodoric—was due to the individual feeling of the artist, Peter Visscher, and they contrasted very well with the other sturdy-looking German figures. Moreover, the German figures were many of them ideal, they were friends, not of his daily and external life, but of his inner life and study. The later tombs appeared to furnish ample limits for what, no doubt, would be the work artists would be called upon to execute in the near future, for they were constantly reminded by individual effort to what was coming. Only a few days ago he was delighted to see, in Mr. Gilbert's studio, one of the most charming memorials in bronze of a man who had passed away which had ever been made. It was not only remarkably beautiful, but seemed to point out the application of this material for such purposes. It was a monument to the late Mr. Randolph Caldecott, and embodied the most charming idea. A little child held the medallion of the artist in her fingers, and the whole ground of the work consisted of children's heads, not conventional cherubs, but real children, surrounding the central figure. It was a comparatively moderate size, and would not be very expensive to reproduce. The question of reviving the *cire perdu* method was rapidly coming to the front. Some time ago an effort was made to induce the Committee of the City Guilds to allow a manufactory to be established at Kennington, but it fell through. He was glad to hear from Mr. Gilbert that he and his brother-in-law were not only experimenting in this matter, but actually found it pay; and when this was the case there was no doubt that others would soon take it up. There was no question that if the demand were adequate to the supply men would be found who could do entirely original and beautiful work. In Mr. Gilbert they had an artist such as England had rarely seen, and probably from his studio would spring a new race of monumental sculptors in this material.

Mr. VINCENT ROBINSON remarked that the old monumental brasses from which the rubbings exhibited were taken, were always on the floors of

churches, and the flat surface seemed very appropriate in that position, but of late he had noticed many instances of flat brass monuments on the walls, with inscriptions, which seemed to him very disfiguring, for they looked very much like name plates for doors, and altogether inappropriate in a church.

The CHAIRMAN said he had no special knowledge on this subject, but he should like Mr. Gardner to explain why brass rather than bronze was always used for the flat brasses. Bronze seemed far more beautiful, and kept its colour better than brass, which generally turned black with exposure to the air. He agreed with everything Mr. Sparkes had said with regard to Mr. Gilbert. He had executed a very great work — the statue of the Queen — for Winchester. No one who had seen that work but but would admit that it showed magnificent conception and treatment, and it was distinctly original. He felt quite sure that if bronze came into more general use for decorative work and statuary, the position which statuary held in this country would be much improved. The sort of dislike which seemed to exist for sculpture was greatly due, in his opinion, to its being always executed in such a repellent material as white marble. It was proper enough when mixed with architecture, but as a monument by itself he thought it was the most chilling and uninteresting material in which a work of art could be executed; if bronze were used, statues would be more common, not only in private houses but in public buildings. The majority of the statues found in Rome were of white marble, but some of them were coloured. A marble head had lately been found in the Acropolis, in which both the hair and the lips were distinctly coloured. He might also mention some bronzes in the British Museum which were almost exactly the colour of a dark Italian complexion.

Mr. STARKIE GARDNER was obliged to Mr. Somers-Clarke for his information about the Queen Eleanor monument, but he thought the statue must be hollow, because bronze was so extremely valuable in those days that they would never have wasted material in that way, and they knew perfectly well how to cast with cores in the centre. You could tell almost by the appearance of many of the tombs that they were hollow. The tomb in the Beauchamp Chapel had also been turned over in a similar way, and the back was found to be beautifully finished, quite as well as the front, showing exactly how the armour was buckled on and put together; and if there had been no other means of information, it would have been on that account alone of great value. It was quite true that we had ound no copper implements in this country, but there was no doubt that the use of copper must have preceded bronze, because copper was found native, and the first thing which would occur to a savage nation would be to apply it to purposes for which it was obviously suited. In America there were remains of a copper age, many implements having been found, as well as a few in Asia, which was evidence that copper preceded bronze, but probably England was not inhabited in the copper age, or else the implements were afterwards melted up and mixed with alloys. He agreed with Mr. Sparkes about the two figures of Peter Visscher's, but still they were ideal figures, while many of the others were contemporaries of Maximilian, for instance, Philip of Spain. They were comparatively clumsy figures, and were arrayed in the clumsy armour of the day. His own feeling with regard to brass tablets was that their day had passed; but still that form of monument might be made very effective if enamelled and gilt, and used murally in the shape of panelling. Very often the brasses were originally gilt, and traces of this were sometimes found, though it had been mostly rubbed off; and they were also enamelled and filled in with colour. He could not say why brass was used in preference to bronze for tablets, unless because it was a somewhat cheaper material, and easier to work; probably, also, it was a new metal at the time, and afforded a contrast in colour, and fashion might have had something to do with it. The marble effigies were coloured and gilt when first made, and probably did not when thus treated look very different to bronze, while they were certainly cheaper. A Capuan Venus had evidently once had a golden head-dress, and colour was doubtless used in this case to soften the effect of the white marble. The life-like appearance of the old bronzes with the glass eyes was something wonderful; he remembered in particular some running boys at Herculaneum, which were of a dark colour, like Nubians, which had an intensely earnest expression. The dull-green colour often found on old bronze was not the original colour but a patina; the dark bronzes were always buried in some impermeable matrix where water could not percolate to them, and the carbonic acid could not act on the surface. We were rapidly moving towards a revival of bronze work, and the completion of the monument to General Gordon in St. Paul's was a most encouraging sign. It was almost the first one in that material which had been erected since the Duke of Wellington's memorial in the same cathedral.

The CHAIRMAN then proposed a vote of thanks to Mr. Gardner, and regretted that he had not had time to exhaust the subject. He had been obliged to omit entirely the extremely interesting story of Italian bronzes, but he hoped that another year they would be able to get a paper from him on that subject.

The vote of thanks was carried unanimously, and the meeting adjourned.

EIGHTH ORDINARY MEEING.

Wednesday, February 1st, 1888; Sir DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Chancellor, Albert, The Retreat, Richmond, Surrey, and The Lawn, Ascot-heath, Berks.
Claudet, Arthur Crozier, 2, Stirling-mansions, Canfield-gardens, Hampstead, N.W.
Hannay, James Ballantyne, Cove-castle, Loch Long, N.B.
Kendall, Arthur G., B.A., 13, Porchester-square, W.
Mann, Frederic John, 17, Essex-street, Strand, W.C., and 110, Tulse-hill, S.W.
Murray, A. H. Hallam, B.A., 50, Albemarle-street, Piccadilly, W., and 30, Grosvenor-road, S.W.
Russell, John, Anchor Brewery, Chelsea, S.W.
Twivey, Arthur, 151, Broad-street, Five Ways, Birmingham.

The following candidates were balloted for and duly elected members of the Society:—

Adams, John William, 74, Oxford-street, Regent-road, Salford.
Bateman, Rev. John Fitzherbert, South Lopham Rectory, Harling, Norfolk.
Brooks, Christopher P., The Mount, Blackburn.
Buckland, Charles, 36, Piccadilly, W.
Butler, John, 11, Redcliffe-gardens, S.W.
D'Aulby, John Edward, London-house, Braintree, Essex.
Edwards, Frederick W., Fairhope, Victoria-park, Walton-on-the-Hill, Liverpool.
Farrer, Sir William James, Bart., 18, Upper Brook-street, W., and Sandhurst-lodge, Berks.
Farrow, Frederic Richard, 32, Craven-street, Strand, W.C.
Fletcher, Frederick William, 9, Broad-street, Golden-square, W.
Gregory, William, Trent Valley Brewery, Lichfield.
Hankin, Major-General George Crommelin, C.B., Newlands, Guildford.
Harrison, John, 15, Tivoli-road, Crouch-end, N.
Holden, Captain H. C. L., R.A., Royal Gun Factory, Woolwich, Kent.
Hubbard, Hon. Evelyn, 38, Lennox-gardens, Pont-street, S.W.
Moseley, Joseph, Cringle-hall, Levenshulme, near Manchester.
Notley, Robert P., 35, Bucklersbury, E.C.
Richardson, William Haden, City Glass Works, Glasgow.
Robertson, G. H., 14, Milner-street, Chelsea, S.W.
Robin, F. R., 169, Albion-road, Stoke Newington, N.
Rogers, Major Richard, Fernclyffe, Battledown, Cheltenham.
Roundell, Charles Savile, M.A., 16, Curzon-street, Mayfair, W.
Smith, Gerard, M.R.C.S., The Acacias, Upper Clapton, E.
Smith, Robert Hamilton, 33, Charlwood-road, Putney, S.W.
Tamplin, Richard William, 1, Lennox-place, Brighton, Sussex.
Weir, Benjamin, Rothsay-house, Balham, S.W.
Wenborn, Major Frederick Moore, 24, Ockenden-road, Canonbury, N.
Willans, P. W., Ferry Works, Thames Ditton, Surrey.
Wilmot, Thomas James, Waterville, Co. Kerry, Ireland.
Woodland, John, St. George's Hospital, S.W.

The paper was read—

THE SWEATING SYSTEM, OR THE FUNCTIONS OF THE MIDDLEMAN IN RELATION TO LABOUR.

By D. F. Schloss.

Just forty years ago the *Morning Chronicle*, a London journal, long since defunct, sent forth a commissioner to investigate the condition of the industrial classes in the metropolis. Amongst the matters to which the report published by the *Chronicle* directed the attention of the public, there was one which aroused an extreme degree of indignation. This was a method of working, recently adopted in the tailoring trade, to which the workmen had given the name of the sweating system. The subject was taken up by Charles Kingsley, whose novel of "Alton Locke" has familiarised not alone contemporary minds, but a succeeding generation, with the unfortunate position of the sweated tailors of 1847. Since that time a great change has taken place in the industrial conditions of English labour; it is now all but impossible to find a single English tailor in the den of a sweater. But the "sweating system," as it has always been called, still exists, not alone in the tailoring industry, in which it first arose, but in many other trades into which it has found its way; and a report recently made to the Board of Trade by its labour correspondent, Mr. Burnett, has aroused afresh the same wide-spread reprobation of the sweaters, and the same vivid sympathy with the sweated work-people, which the writings of Mr. Kingsley first called forth.

The system (it is well known) is not universally prevalent among all forms of

industry, or among all branches of any one industry. The persons who receive the low wages and work the long hours which are shown to prevail among the operatives employed by the sweaters are the least-skilled and the most undisciplined workers in the least-skilled departments of their several trades.

That in the present overcrowded state of the labour market employees of this type find it difficult to earn wages perceptibly superior in amount to the bare cost of subsistence; that in order to earn these wages persons of this class—as Mr. Burnett shows to be the case in regard to the sweated tailors—are compelled to work fourteen or more hours in the day, when there is work to be had; and that on very many days these people are altogether unable to obtain employment—all these facts are so familiar, that the painful statements contained in Mr. Burnett's report on the sweating system, though they must have caused regret to all, can have surprised but few.

Familiarity with social facts of a distressing nature is at times liable to breed, in a greater or less degree, a feeling not remotely allied to indifference. It appears scarcely worth while to devote any large measure of attention to circumstances whose very universality appears to us, in a manner, an ample explanation, if not a sufficient justification of their existence. At any rate it seems as if we could do nothing to put an end to a state of things, for which no one in particular is pointed out as responsible. But the case is altered when the finger of scorn is raised against some person or persons whom public opinion, guided by the voices of the victims of industrial tyranny, selects as the cause of the mischief. To attack an individual is both difficult and dangerous. To prove specific allegations as to the conduct of an individual may not always be easy; while the risk of an unsuccessful defence to an action for defamation is one not lightly to be incurred, even in the interests of oppressed humanity. On the other hand, to attack a class is nearly always possible and always safe. For every class of men includes some members who are a disgrace to it, and by treating these men as fair samples of the whole class, the philanthropic defendant would in an action for libel be in a position to plead some sort of more or less specious justification. And then, of course, no action for libel will lie at the suit of a class.

Whom are we by our reprobation, if not by stronger retribution, to punish as the authors of these intolerable evils? This is at all times the question which excites the greatest degree of public interest; and, indeed, unless vituperation—violent and vindictive vituperation—is a part of his programme, no social reformer can feel himself secure of catching the ear of every audience.

There are, however, many persons whose too clement nature makes them view with disfavour any vigorous onslaught upon any body of men, however little that body may, according to the speaker, deserve to be treated with even the smallest degree of reticence. To meet the soft-hearted prejudices of those too charitable individuals, it is found best to refer as little as possible to the men whom you propose to attack—even as a class. It is preferable to avoid abuse of individuals, even collectively, and to direct your assault against some impalpable entity to which you give the name of a system.

The considerations which have just been adduced will explain much that is mysterious in relation to our subject, both in regard to its popularity and to its somewhat unpleasant, and certainly unscientific, terminology. A sweater, if we may be allowed to suggest a definition, is an employer who exacts from his workpeople an excessive amount of work in return for an unreasonably low remuneration. It is necessary, however, to point out that this tentative definition is unduly wide in its comprehension.

There are many operatives who are in receipt of a miserable pittance as the remuneration of labour protracted through hours of employment of cruel length, but who, all the same, are not said to be sweated, simply because no one has ever had the courage to stigmatise as a sweater the employer of these unfortunate people. Most of us have read with feelings of burning indignation, how Melenda, the shirtmaker, in Mr. Besant's "Children of Gibeon," toiled from early morn until far into the night to gain the starvation wages doled out to this poor girl by the despotic foreman of the shopkeeper for whom these shirts were made. But this shopkeeper, so far from being branded with the detested appellation of sweater, was probably known to the public, if at all, as a highly respectable tradesman, noted, very probably, for his strong philanthropic tendencies.

Any reader of Mr. Besant's charming and most truthful romance might well be of

opinion that, if the payment of low wages, and the exaction of an unreasonable amount of labour, constitute the qualifications of a sweater, then we have in this typical employer a true member of this hated class. But the term "sweater" is admittedly inapplicable in the case of a manufacturer whose work is given out direct from his own premises. In order to make this statement perfectly clear, let us suppose that Mr. Besant's shopkeeper, instead of selling, say, 500 shirts every week, enters upon business of a more wholesale character, and now requires to provide for the making every week of 5,000. Under these circumstances he will find it practically impossible to seek out for himself a sufficient number of workers to perform all the labour necessary to this increased output. He must, therefore, look for a number of responsible persons who will take the material for the shirts from the warehouse, and will agree to return them finished at a specified price per dozen. Each of these contractors will give out a part of the shirts undertaken by him to women in the position of our friend Melenda. Where the contract is on a large scale, it will possibly be sub-let in fractions to sub-contractors. It is only the employer at the bottom of the scale, whether that employer be a contractor or a sub-contractor, that is called a sweater. In the words of words of Mr. Burnett, p. 5, "The intermediate agents, who neither work themselves nor employ workmen, are not called sweaters. It is only the men who take the work, either direct from the chief clothier or contractor or from intermediate agents, and who employ men, women, or children to execute it for them, that are sweaters."

If we ask for what reason these intermediaries are exempted from inclusion in this evil category, the answer is not far to seek. The only one of these contractors or sub-contractors with whom the sweated operative comes into actual contact is, obviously, his or her own immediate employer; about the men who stand above this employer in the hierarchy of industry, the sweated worker knows nothing, not even enough to abuse them. For the man from whom he receives the price of his labour, the "sweater's victim" reserves the title which has now found its way into the language of the social reformer, and we have no right to attach to this term a wider significance than that which is attached to it by those from whose vocabulary it is borrowed.

We have now arrived at a clear conception of the class of employers to whom the name of sweater is properly applicable. The common characteristics of all sweaters we have seen to be the payment of insufficient remuneration in return for an excessive amount of labour.

The next point to which our attention must be directed is the determination of the standard by which, in any particular case, we are to judge of the sufficiency or insufficiency of the wage, and by which we are to decide what hours of employment are, and what are not excessive. In order to do this, we must make up our minds from what point of view we are going to look at this question. From the point of view of political economy, the fair price of a man's labour is that which this labour will fetch in the industrial market.

If this is to be the standpoint which we are to take up in our consideration of the sweating system, then we must dismiss the whole subject with the simple but perfectly correct and conclusive observation—*cadit quæstio*—there is nothing for us to discuss. In the view of the economist, no wages, however low, are insufficient; no hours of employment, however protracted, are unreasonably long—provided always that no other compulsion than that of poverty induces the operative to agree to work for these wages, and during these hours.

However, to discuss the question of sweating with that shrug of the shoulders which constitutes the characteristic rejoinder of the political economist, when brought face to face with the results produced by the working of the laws of his science—is for us, at any rate, altogether impossible. What we mean by insufficient wages we know well enough; we intend by that phrase to denote wages insufficient to defray the cost of all the necessaries, and of some at least of the comforts, of civilised existence. When we speak of hours of employment unreasonably long, we allude to those cases—now, unfortunately, only too numerous—in which, when the day's work is over, no time at all is left for recreation, and but little for sleep. That the wages of the sweated operatives, and their hours of employment, are in very many instances of this character is a fact which no one who has even glanced at the pages of Mr. Burnett's Report will think of denying.

The emotions are no doubt out of place in pure science, and we cannot expect that the state of things disclosed by Mr. Burnett's investigations should arouse indignation in the mind of the devotee of political economy, or should be regarded by him otherwise than as an interesting illustration of

the law of supply and demand, as applied to the market for human labour. Be this as it may, the condition of the sweated industries is one which most of us, to whatever school of thought we may profess adherence, regard with feelings by no means allied to the comfortable equanimity of the political economist. In truth it can, with but little exaggeration, be said that, at the present moment, men who think at all, and who think of others as well as of themselves, are either Socialists who call themselves philanthropists, or philanthropists who call themselves Socialists. Thus it has arisen, that the outcry of some is against "an application of political economy, uncontrolled by the moral laws of human sympathy;" while the watchword of others is the text, "He that will not work, neither shall he eat." This much, at least, appears certain. The common consensus of all of us is—that rank heresy in the eyes of the political economist—the doctrine that all men ought to have to eat, more or less, in proportion to the work which each shall do, so that none shall surfeit in voluntary, none starve in involuntary idleness, but for all alike work, not unduly onerous in its nature, shall be found—work, the performance of which shall be rewarded by a remuneration sufficient in amount to place the citizen and his family in a position secure from all danger of indigence and all fear of degradation.

Let us, therefore, frankly confess that for us the evils of the sweating system are evils, the existence of which no sneers of the consistent individualist will induce us to permit, if any efforts of ours can procure their immediate and complete abolition. For us, therefore, it is of paramount importance carefully to diagnose the social disease, in order to discover, if we can, any means within our power that may secure its remedy. So much has been quite recently written and spoken on this subject, that any detailed account of what is known as the sweating system will not be needful in this place, and my remarks will take the form of comment rather than of description. At the outset let us clear our minds of some few misconceptions that have, until lately, prevailed with regard to the system which we are discussing.

The first misconception, which it will be my duty to remove, is the fundamental idea, that the sweating system, as a system, possesses any existence whatever. To speak of certain low-class industries, which have nothing in common except the absence of skill, and the consequent overcrowding of the labour market in these trades, as if all these industries were carried on upon one common plan, and to call that plan a system, may be a convenient, but is certainly an inaccurate treatment of a question in which accuracy is of no small importance.

That the sweating system is, in truth, no system at all, will be abundantly clear to any one who has ever wasted his mental energies in the impossible attempt to discover a definition capable of application in the case of all sweated industries alike, and capable of application to these industries alone.

If, however, we abandon all attempt at definition, and confine ourselves to an inquiry into the origin and real nature of those industrial conditions, to which the name of the sweating system has, for the last forty years, consistently been applied, we shall be in a better position to classify these phenomena. The sweating system, as is well known, took its rise in the tailoring industry under circumstances which fully account for its introduction. The extension of the scale upon which business was carried on in this trade, consequent in part upon the increase of population, and in part upon the superior economy attendant upon all business carried on upon a large scale, the introduction of the trade in ready-made clothing required in large quantities for the home, but in far more extensive quantities for the colonial, and especially for the new Australian markets, and the introduction of machinery—all these factors rendered it practically impossible for the conditions of the tailoring industry to remain unchanged. The first step taken was for the master-tailor to abandon his former custom of manufacturing all his goods in his own workshop, and to adopt the practice of giving out work to his journeymen to execute in their homes, with the assistance of members of their own families. Thus, in the words of Mr. Burnett (p. 1), "the master-tailor was spared the expense of finding workshop accommodation, with all its concomitant charges. He was relieved of the cares of constant supervision of his workpeople, who, being paid at a given rate per garment, were their own taskmasters." With regard to the description given by Mr. Burnett, in the words just cited, it is to be observed that the mode of working in which, according to this authority, the sweating system took its rise, is one which ever since its introduction has been universally adopted, and at the present moment actually prevails

in all, even in the highest departments of the tailoring industry. It is, in fact, a simple method of what may be termed "home work;" and, as anyone can perceive by a perusal of Mr. Burnett's account of the actual working of the sweating system, has but the very slightest affinity with any form of sweating. A man working at home in this manner cannot be said to sweat himself; a father getting work direct from the shop, and doing this work with the assistance of his child, has never yet been spoken of, in relation to this child, as a sweater.

The temptation to a journeyman to take from the shop more work than he could perform with no other assistance than that of his family, soon led to the employment of strangers in addition to the family; and the journeyman in his turn became a small master—a contractor. It is in this development of the new method of working that we shall discover the primordial type of sweating. The description of this mode of working, which is given in the pages of "Alton Locke," enables us to perceive that all the evils which at this moment characterise the lowest forms of sweating in the ready-made trade, were, forty years ago, prevalent in at least an equal degree in the workshops then conducted upon "the sweating system."

What, however, is to be remarked is this: So far as concerns the bespoke trade—the manufacture of garments to the order of the customer—the system of working remains unchanged; but the evils that in Kingsley's day characterised this system have long since disappeared, nor are any of the employers under this system ever referred to as sweaters. Readers of Mr. Burnett's report on the sweating system cannot fail to have observed that its pages contain no single reference to the higher branch of the tailoring industry. And yet the system upon which bespoke work is done in Whitechapel for many tailoring establishments of good repute, is in every particular identical with that upon which the making of stock garments of the commonest variety is carried on in the dens of the lowest class of sweaters. The practical difference in regard to the wages of the work-people, the hours of labour, the regularity of employment, and the accommodation provided, is wide indeed—wide as the difference in quality between the frock coat which decorates the elegant frame of the dandy in Piccadilly and the cheap jacket worn by the costermonger in the Ratcliffe-highway, or by the diamond digger of Southern Africa. The contractors in the bespoke trade, except in occasional short periods of slackness, work the full week; their hours are, as a rule, twelve in the day, inclusive of meal-times; their workmen, if fairly expert, receive about thirty-five shillings a-week; their workshops are of adequate proportions, and, in most cases, free from sanitary defects. The converse of this picture, the den of the slop trade sweater, has been portrayed by Mr. Burnett in his report. The days on which the sweater engaged upon the lowest class of garments can find work for his hands are, taking one week with another, but three out of seven; the hours of employment are seldom less than fourteen, and often as much as sixteen, out of the twenty-four; the remuneration received by the workers is meagre in the extreme; while the places in which their cruel tasks are performed are in many cases overcrowded and insanitary.

The marked contrast which exists between the industrial conditions exhibited in the workshop of a contractor in the bespoke and those of the sweater's den in the ready-made trade, while the system under which each of these employers works is identical in each case, serves to prove, beyond the possibility of doubt, that the evils which are supposed to characterise this system are by no means inherent in the system itself.

The term "sweating system" is, in fact, only the name which is applied to a partilar method of working when there exist, concomitant with its application, certain deplorable conditions. These conditions, however, are by no means the constant accompaniments, much less the true effects, of this method of working, to which, for want of any generally recognised title, we will give the name of the contract system. The sweating system, then, is to the contract system what usury is to interest, or, to borrow a metaphor from another class of facts, what a sick man is to mankind at large. But has any writer yet attempted to treat of usury as an economical phenomenon, specifically distinct from interest? Or would any sane physiologist erect paralytics into a separate class by way of contra-distinction to the *genus homo*?

It is the misfortune of the contract system that the attention of the public should have been exclusively directed to what we must regard as the excess and abuse of this system. Happy, it may be, is the nation which has no history; but most unhappy is that nation, or

that class, which finds its good deeds and its happier moments veiled in obscurity, while upon its crimes or its misfortunes is cast the lurid light of Governmental investigation and journalistic discussion.

Those who are familiar with the general history of contemporary industry must, indeed, take a very different view of the contract system from that which is necessarily formed by persons whose acquaintance with this system is confined to its seamy side. Not alone in the tailoring, but in very many other manufacturing industries, has the contractor, for many years past, fulfilled important and most useful functions. To take an instance from the portmanteau and bag trade. Many of the articles offered for sale by so-called trunk-makers are manufactured by contractors; indeed, until quite recently, this statement might have been made with accuracy as to nearly every trunk or bag sold in London. Some of the contractors carried on their trade in workshops provided by the master trunk-makers; these men were called "piece-masters." Those contractors who have workshops of their own are termed "garretteers." The reason which makes it proper to use the past tense in speaking of the piece-masters is not without instructive interest. Very nearly all the piece-masters, and, indeed, many of the garretteers, have been crushed out of existence between the fall in the prices paid to them by the shop-keepers and the rise in wages successfully demanded by the men. The work in this trade is now for the most part carried on under foremen, in workshops maintained by the master trunk-makers, or in the homes of the journeymen, in which they work with the assistance only of their own families. In the saddle and harness-making industry, the contractors, who formerly had in their hands the bulk of the work, are day by day decreasing in numbers. Their profits are incessantly diminished by competition among themselves, each offering to take the work from the shop-keeper at a figure lower than that demanded by his neighbour. At the same time the men, strong in the knowledge of their own skill and of the consequent inability of their employers to replace recalcitrant workmen, and aided by effective combination among themselves, render it absolutely out of the question for the contractor to increase his own gains by any diminution in the wages of his employees. A great number of the hats sold by the London hatters are made, not on the premises of the shop-keeper, or in the factories of Stockport, Denton, and other manufacturing centres, but in the workshops of small contractors in London, who in this trade also are called "piece-masters." To these contractors neither the term sweater nor any equivalent appellation has ever been applied. The work on which they are engaged is chiefly bespoke work of good quality; the inferior stock goods being sent to the metropolis from the large country factories. In the trade carried on by these contractors and those in some other industries—the manufacture, for example, of plate-chests—the labour is skilled, and for this reason, the industrial conditions of the operatives, who work for these small employers, are such as to give no cause for complaint. This, in fact, is the whole truth of the matter. Given an industry in which skill is essential, the position of the workman, whether he work under a foreman or under a contractor, will be one of reasonable competency. Given a trade in which the amount of skill required of the workman is infinitesimal, that workman, under whatever method of working he be employed, will inevitably be overworked and underpaid. Where the supply of labour of a certain class is limited—as that of skilled labour always must be—here the operative can compel his employer to concede to him reasonable terms of employment. The strike is the true sanction of industrial morality. But a successful strike of crossing-sweepers, of tenth-rate slop-trade machinists or basters, of "sandwich men," or of sweated boot finishers, is beyond the pale of practicability.

Before, however, we discuss the considerations of the important results in relation to the contract system generally, and in particular to the position of the employee, consequent upon the unskilled nature of his occupation, we will take a cursory glance at a trade in which the contract system has long prevailed, and in which, in different branches of the trade, diverse grades of skill are exhibited in the labour employed. If we examine the boot-making trade in its different departments, we shall find that the very best boots of all are made by workmen employed directly by the shopkeeper. Yet, even in first-grade boots, a certain amount of work—good work, but not the very highest in quality—is given out by the shopkeeper to contractors, called "chamber-masters." It is the duty of the chamber-master to perform part of the work himself, while the remainder is done by workmen employed by him. The reason which causes the employment of these contractors is not far to

seek. The very best men in a trade are willing to exert their fullest energies with a minimum of supervision. But workmen of a lower industrial type, even when paid by piece-work, are found to require an amount of supervision which the shopkeeper cannot find time to exercise in person. It might, indeed, be supposed that the superintendence required might be entrusted to a foreman. In practice, however, it has been found that the superintendence exercised by a foreman is insufficient to secure the proper performance of the work. Since the amount of the foreman's salary does not depend upon the amount of work which he extracts from his subordinates, the supervision of a foreman is, in many cases, of too perfunctory a nature to secure its object. It becomes necessary to deal with the journeymen—the closers and the makers—through the intervention of a superintendent remunerated by profit, and not by time wage. This, then, is the true conception of the industrial function of the contractor. The chamber-master is simply a foreman remunerated by profit instead of by time wages.

When we come to boots of lower quality than the first grade article, but still of fairly good workmanship, we find that the contract system, so far as the metropolis is concerned, is widely prevalent. The contractors in this middle-class trade are, like those in the first-class branch, called "chamber-masters," and, though the system upon which the work is carried on under these men is identical in all respects with that which, in relation to less skilled industries, is known as the sweating system, no one has ever dreamed of applying to them the appellation of sweater, or of suggesting that they treat their workmen otherwise than justly.

There have been—there always will be—occasional disputes as to the rate of wages between the chamber-masters and their journeymen. But these men hold their own against their employers, and the wages* which they receive compare favourably with those of any other class of British workmen.

Coming now to the lowest grade of all, machine-made boots, chiefly for women's wear and of the most inferior quality, we find that in this department the work is cut up into numerous sub-divisions, each allotted to a distinct class of workmen. If we were to arrange these sub-divisions according to the amount of skill demanded in each, we should find low down in our list the work of the laster, and quite at the bottom of this list that of the finisher. Amongst the other classes of operatives, there are none who are employed by sweaters; in the lasting there is but little sweated work; in the lowest branch of all—the finishing—the sweater is, so far as the London trade is concerned, predominant. It is further necessary to remark that, in this sweated boot trade, no English labour is employed, the British workman being naturally unwilling to engage in an industry the conditions of which are so little advantageous to the operatives. These boot finishers (sweaters and sweated alike) are Jews, most of them persons who, within a recent period, have been driven to this country, in some cases by poverty, but in the majority of instances by religious persecution, from Russia and Poland. In the circumstances of the boot-finishing industry as carried on by these sweaters, we may see exemplified the worst evils attendant upon the contract system when applied to industries in which only a very small degree of skill is required. Both employers and employees work eighteen hours a day for at least five days out of the seven, while the labour of the latter is remunerated at the rate of 3½d. per hour.

Enough will now have been said to secure the conviction that to attribute the evils, which undoubtedly characterise the sweated industries to the system under which these industries are carried on—the contract system—is absurd. But—it may be urged—even if the system be responsible for these evils, many of the worst of these deplorable circumstances must be admitted to be due to the exactions of the employers under this system, or of a certain class of these employers, those contractors, that is, who are known as "sweaters." Granting that it is the want of skill in the workers that is the cause of the overcrowded state of the labour market, and that compels these poor people to accept these low wages, and to perform in return for these wages any tasks however onerous; is it not the fact that the misery and incompetence of these employees is taken advantage of by their employers? and are not these employers in this manner enabled to secure to themselves profits which, in comparison with the wretched pittance doled out to their work-people, are most unfairly large?

The sweater is, according to the popular conception, a middleman who obtains for

* For a fuller account of the working of the contract system in the higher departments of the boot trade, and of the earnings of the operatives and their employers respectively, see the article on the sweating system, by the author of this paper, in the *Fortnightly Review*, December, 1887.

himself, by overworking and under-paying his work-people, a life of almost absolute idleness and of relative affluence. The allegation that a man is a middleman is, in these days of co-operative associations and of univeral providers, in itself a formidable accusation. The middleman is the common foe of all consumers, against whom the hand of his fellow-men is raised as against a useless encumbrance in the organisation of society. But a cursory examination will disclose the fact that there are among the members of the sweating tribe but few to whom the title of middleman can be given without impropriety. As to the contractors who take work from the warehouse, and give it out to smaller men, and who do not themselves employ workpeople to do this work, these are no doubt true middlemen. But then we have been told by Mr. Burnett (p. 7) that these intermediate agents who neither work themselves nor employ workmen are not called sweaters. As to the other class of contractors, the actual employers of the work-people, these men are indeed called sweaters, but can in few cases be correctly described as middlemen; for, as a rule, these employers take an active part in the making of the garments, and, with very rare exceptions, all of them exercise a vigilant and quite indispensable supervision over the work of their employees.

With regard to the small sweater in the coat trade, Mr. Burnett declares (p. 7) that this man "works as hard, or harder than any of his *employés*, and can spare but little time to see that his workpeople sweat as much as he does himself." As to the sweater in the trousers and vests trades, whose workers are employed in their own homes, it has recently been stated by a writer thoroughly conversant with the subject (Miss Beatrice Potter, in the *Charity Organisation Review*, Jan. 1888, p. 16) "that he gives the work out and gathers it in; repairs mistakes, and frequently presses the garments; and is as much a superintendent of labour as his brother of the workshop." This remark of Miss Potter's is, indeed, applicable not alone to most of the sweaters in the tailoring trade, but to the great majority of all other sweaters in the boot-making, the cabinet-making, the shirt-making, and the rest of the sweated industries. These sweaters, in fact, are not middlemen at all, but are just as clearly entitled to the name of producer as the foreman of a factory, whose right to this appellation no one would dispute.

Another misconception very widely existing in relation to the sweaters is, that these contractors as a rule make large profits. This view is in very many instances the exact converse of the truth. Strange indeed would it be if the merchant tailor, for example, were to allow the contractor to put into his pocket money which this tradesman could so easily secure for himself by cutting down the contract prices of the garments given out to this subordinate employer. As a matter of fact, when the contract system is first introduced into any trade, the profits of the contractor begin by being unreasonably large. This was the case forty years ago in the tailoring trade, and is the case at this moment in the sweated boot-finishing, an industry of recent origin. But this very disproportion between the wages of the worker and the gains of his employer brings about its own remedy.

It becomes the ambition of every worker to commence business at the earliest possible date as a contractor. In this way the number of contractors is speedily augmented, and their fierce competition for work, which they take at ever lower and lower prices, brings about before long a serious diminution in their profits, until at last these are reduced almost to the level of the wages received by their workpeople.

This general statement will best be explained by an illustration taken from the tailoring trade, in which the contract system has had ample time to develop the tendencies to which our attention is now directed. We will proceed to ascertain, with as much precision as may be possible, the amount of the profits which, as a matter of actual fact, are at the present time earned by the average sweater in the slop trade.

In order to frame our calculation we will avail ourselves of the figures* supplied by Mr. Burnett (pp. 14, 15), in the form of "A Practical Tailor's Estimate of a Sweater's Profits." Mr. Burnett supposes his representative sweater to turn out 40 coats per day, and to receive for the making of these coats (the cloth being given out to him ready-cut by his employer), 1s. 2d. per coat. Out of this price of 1s. 2d., Mr. Burnett tells us that the sweater, after paying the wages of his workpeople and the cost of the trimmings provided by him, will find himself with a margin of 3½d. per coat, "for rent, machines, firing, &c.," say, 11s. 8d. per day. What the man

* For a fuller discussion of these figures see the article by the writer of the present paper in the *Charity Organisation Review*, for Jan., 1888 (Longmans).

is to be reckoned to pay for rent Mr. Burnett does not suggest; nor does he give us any indication of the other expenses which are included in the "&c." The sweater's machines, of which for the output supposed Mr. Burnett tells us that he will require three, will cost him —as Mr. Burnett in another place (p. 6) informs us — 7s. 6d. per week, which he will have to pay to the sewing machine company for their hire. An important point to observe is that, as the average sweater can only find work for three days out of seven (see p. 15), the amount of his rent (which cannot well be less than 4s.), and that which we must allow him for the hire of his machines, or (if he owns these machines) in respect of interest on their cost, depreciation, and repairs of plant (say 2s. 6d. per week), must be distributed as working expenses equally between the three working days—say rent 1s. 4d., machines 2s. 6d. (if hired), or 10d. (if owned), per day. We must also allow the man one shilling per working day for the gas which he burns, and the coke used for heating the irons of his presser, 1s. per day for the porterage from and to the warehouse of the daily output of coats, and 4d. per day for tea (which all sweaters supply free to their workers). The sum total of all the working expenses, which must be deducted from this daily margin of 11s. 8d., thus amounts to 6s. 2d., leaving a balance of 5s. 6d. a day, a balance which, if the sweater be assumed to own instead of hiring his machines, will be increased to 7s. 2d. If we turn to the table of the wages which this sweater is supposed by Mr. Burnett to pay to his men, we shall find that his principal machinist and his presser each receive 6s. per day. It should be remembered that this sweater must be taken to act as his own "fixer," a workman quite as important and as valuable as a presser or a chief machinist. Out of the 7s. 2d. per day which the sweater earns, 6s. must therefore be reckoned to be earned by him in his capacity as workman. The gains of the average sweater, as sweater, are thus seen to exceed by no more than 1s. 2d. per day, the wages of his employees. This excess of about 19 per cent. constitutes the remuneration received by the sweater for the anxious and arduous task of supervision—a remuneration the amount of which will hardly be considered to be one of unreasonable proportions.

It is true that contractors—even contractors in the slop trade, whose business is carried on upon a scale more extensive than that of the average sweater, and who are engaged in the manufacture of higher priced garments than these 1s. 2d. coats—are able to earn profits far more considerable than those we have just stated. But, on the other hand, these large contractors, as may be seen by the information supplied by Mr. Burnett (see the facts as to Mark Moses, at pp. 13, 14, and 17), provide their operatives with employment fairly regular in character, and, in return for an amount of work, which can scarcely be called excessive, pay to their workmen wages averaging 5s. to 6s. per day. A man, whose working hours are about twelve in the day, and who receives 25s. to 30s. a week, can hardly be said to be sweated, and the large contractors cannot without injustice be classed as sweaters. As for the small contractors, engaged upon the lowest class of work, these—the true sweaters—earn scarcely enough to keep body and soul together. In the emphatic language of the Labour Correspondent of the Board of Trade :—"The lower class sweaters, who do the commonest work, have the lowest prices, pay the least wages, and exact the maximum of toil from their workers—make little more than a bare subsistence, and earn little, if any, more than the best of their own workpeople."

So far we have been dealing with three only out of the four principal characteristics of the sweated industries, with under-pay, over-work, and irregularity of employment. The last and by no means the least of these characteristics —the unsanitary conditions which prevail in the workshops of the sweaters—remains to be mentioned. The description of the dens of the East-end sweaters given by Mr. Burnett (p. 7), reads as follows :—

"The character of the workshops or places used as workshops, varies considerably. The smaller sweaters, as has already been remarked, use part of their dwelling accommodation; and in the vast majority of cases work is carried on under conditions in the highest degree filthy and unsanitary. In small rooms not more than 9 or 10 feet square, heated by a coke fire for the presser's irons, and at night lighted by flaring gas jets, six, eight, ten, and even a dozen workers may be crowded. The conditions of the Public Health Acts and of the Factory and Workshop Regulation Acts are utterly disregarded; and existing systems of inspection are entirely inadequate to enforce their provisions, even if no divided authority tended to weaken the hands of the inspectors. At a moderate computation there must be at least 2,000 sweaters in the East-end of London, and of these not one-third can be known to the factory inspectors, hidden as

their shops are in the garrets and back rooms of the worst kinds of East-end tenements. A tour of inspection of a few of these places, and of the people therein employed, gives some idea of the misery and extent of the system; and there can be little doubt that a rigid enforcement of the Acts above referred to, with a cordial co-operation between the local sanitary authorities and the inspectors of factories, would do much to make life more tolerable to the workers, and tend to improve also the general condition of the trade. After the small house workshops come those built over the backyards of the houses, which, if not clean or comfortable, are more spacious and better ventilated; but even some of these are but miserable places, where men and women are huddled together without regard to either health or decency."

The language here used by Mr. Burnett appears to me (and I, as Hon. Secretary of the Sanitary Committee of the Jewish Board of Guardians, have an extensive personal acquaintance with the abodes of the sweaters) to be somewhat too sweeping in character. But, in any case, the number of sweaters' workshops in which all or most of the features mentioned by Mr. Burnett are to be found, is, beyond question, sufficiently large to arouse our justifiable indignation, and to necessitate—it is submitted—the interference of the Legislature. The existing factory laws require amendment. From the operation of the provisions which these statutes contain as to the sanitary condition of factories, two classes of workshop are by Sec. 61 altogether exempted, those, that is, "in which the only persons employed are members of the same family dwelling there," and those "conducted on the system of not employing children or young persons therein."

The condition as to over-crowding and sanitation of workshops belonging to either of these classes is a matter which the Legislature has left to the control of the local authority in each district. Although certain of these authorities exhibit some, though by no means sufficient, activity in regard to actual sanitary defects, yet with respect to the over-crowding of a workshop, any interference on the part of a sanitary authority is a thing practically unknown in the annals of history. The over-crowding and the insufficient ventilation of workshops are matters which the Vestries appear to consider to be the exclusive concern of the factory inspectors. But, since the dens of the sweaters almost invariably come within the exemptions of sec. 61, the factory inspectors are, in very many cases, powerless to intervene in respect of these very important matters. This fact is conclusively proved by the results of a house-to-house visitation, made in the districts in which the sweaters "most do congregate," by Mr. Lakeman, H.M.'s Senior Metropolitan Inspector of Factories, and two other officers, and stated in the Report of the Chief Inspector of Factories and Workshops for 1884, pp. 35, 36. Out of 1,478 workshops so visited there were found to be no less than 724 in regard to which the inspectors had no jurisdiction whatever, and a further number of 387 in which these officials possessed no jurisdiction over their sanitary condition. Thus, in respect to more than three-fourths of these workshops (1,111 out of 1,478), no matter what their sanitary condition was found to be, the factory inspectors could do nothing. What the actual condition of these places was, may be judged by the fact that, in as many as 907 cases out of these 1,111, the inspectors discovered the existence of serious sanitary defects. So long as our factory laws remain in their present unsatisfactory state, all that a sweater has to do in order to escape the necessity imposed upon other employers of labour of providing sanitary and sufficient accommodation for his workers, is either to allege that all these workpeople are in some degree related to him and reside under his roof, or to abstain from employing juvenile operatives, an abstention which does not involve any kind of self-denial, for, as Mr. Burnett points out (p. 8), in the sweaters' workshops "very few children are employed, child labour being too slow, and requiring too much supervision to be found profitable."

The factory laws must be so amended as to abolish these peculiar privileges of the sweater. The result of an amendment of this nature would be not alone to effect an improvement in the sanitary conditions of all the sweated industries, but also to put an end altogether to operations of many, and these just the most vicious among the sweaters. As we have seen, the profits made by the lowest class of sweaters at the present moment exceed but slightly the bare cost of subsistence; and, if called upon to defray the cost of providing proper accommodation, the small sweater would inevitably succumb beneath this new burden. The work now performed in these unhealthy places would thus be transferred to factories established by the wholesale clothiers, or to workshops of larger and more respectable contractors. As Mr. Burnett has remarked (p. 1)

"the larger workshops tend to approximate to the factory system." It is in the work-rooms of the smaller sweaters that the industrial conditions are of the most degraded type. It is the endless multiplication of small sweaters, and their internecine rivalry, that has brought down not alone the price paid by the master tailors to the sweaters but also the wages paid by these small employers to their workpeople, to the deplorably low level that has now been reached. Any measure that would close for ever the doors of the dens in which the small sweaters now carry on their miserable avocation, would unquestionably bring about a marked improvement in the social and industrial position of the slop-tailors.*

When this has been said, it remains to make —and to make in full and precise terms—the painful confession that the benefits which it would be possible, by an amendment in our factory laws, to confer upon the workpeople employed by the sweaters would of necessity be confined to but a small portion of the many thousands of unfortunate toilers who at present find their lives embittered by the evils attendant upon "the sweating system." By any amendment in the Factory Acts which it would be practicable to devise and to carry through the Legislature, those forms of the sweating system in which the work is performed in the homes of the workers would remain untouched. In the tailoring industry, for example, the Factory Acts, amend them as we will, can only be applied in the case of the coat-makers.

The making of coats, as readers of Mr. Burnett's report will be aware, is a distinct industry, and is in the hands of a distinct class of persons who, as pointed out by Mr. Burnett, are almost universally persons of foreign birth or extraction. As to the other departments of the tailoring industry, the making of vests, trousers, and children's suits, Mr. Burnett has given us but scanty information. He appears to have confined his investigations to the operations of the coat-makers. So much at least is clear: the greater part of the work in these branches of the trade is done, not in workshops, as in the coat-making, but in the homes of the workers; so that no amendment of the factory laws could embrace within its purview the places in which these industries are carried on, or could do anything to improve the position of these operatives.

With respect to the condition of the workers in the trousers, vests, and children's suits trades, who, it may be remarked, are (with a few insignificant exceptions in the trouser making industry) English women employed by English sweaters, Mr. Burnett, although he does not furnish any details procured by his personal inquiries, borrows from a report prepared by the managers of Toynbee-hall, Whitechapel, a few striking statements. These sufficiently indicate the miserably low remuneration received by the worker in these trades, whose labour is protracted through hours of employment so long as to inflict, it is to be feared, terrible injury upon the health of these poor women, and upon that of the offspring that may be born to them. One trouser machinist is mentioned to have earned 11s. 11d. in a very good week; a second trouser finisher, "who is paid 4d. per pair for large, thick trousers, which she gets from a woman in the same house, who herself gets it from a sub-contractor," could make 6s. or 7s. per week. Another trousers maker "can only earn 1s. 6d. to 2s. per day, out of which she has thread to find." With regard to the earnings of the women engaged in making vests, we find among those mentioned in this report one who could not earn "5s. a week even by working from 7 a.m. to 12 or 1 a.m., and sometimes sat up till four in the morning to finish work," while another "in good trade can make 2s. a day."

Turning to the manufacture of children's clothes, we find that one woman who works for a female sweater "makes knickerbockers at 1½d. a pair, and can earn 5s. 6d. per week." Another "makes children's suits—coat and 'knickers'—for 4½d. and 2d. for finishing, but has cotton to find. Working 10 or 11 hours per day, can make 4s. 3d. a week." A third case cited by Mr. Burnett is "that of a woman of 55, and one of 24, who make children's suits of two garments. The prices for making the whole, except a little braiding, done after the work is sent back, range from 3d. to 11d., with cotton to find. One week they started at six in the morning and worked until midnight each day, and made much above the average on suits at 3s. per dozen. Their total was 8s. 6d. for the week, or 4s. 3d. each. Their average weekly earnings they estimate at 3s. or 3s. 6d., enough to pay the rent of their one little room, and find them in tea and bread. Both women had been bound

* A fuller account of the provisions of the Factory Acts, their working in relation to the sweated industries, and of the amendments, which appear to the writer to be called for, is contained in the article already referred to. (*Charity Organisation Review*, Jan., 1888.)

to this trade for three months, and one had given three months' work to learn it."

Upon these statements it is proper to make two comments. The wages of which we have just read are the wages of experienced and industrious, even if not specially efficient workers, not of beginners. Further, although these earnings are indeed nothing better than starvation wages, we must remember that the report from which Mr. Burnett has quoted, was prepared in the year 1884; and Mr. Burnett tells us that "during the three years that have elapsed since the date of this document prices seem to have fallen to some extent."

With regard to the wages received by women working for sweaters in the trousers, vests, and children's suits trades, the figures quoted by Mr. Burnett enable us to form some sort of estimate of the amount of labour which these poor women must in many cases perform in order to gain the means of subsistence. There remains, however, one very extensive industry in which the sweating system prevails to a large extent, and in which the position of the workers is at least as wretched as that of these tailoresses, but of which no mention is made in Mr. Burnett's report. For half a century have poets sung the song of the shirt, and successive generations of philanthropists have wept over the woes of the shirt makers. Unfortunately, the familiarity which the public has acquired with the misfortunes of these most unlucky of Englishwomen has not only done nothing to improve their condition, but has failed to remove the fundamental misconception which has hitherto prevailed as to the cause of their misfortunes. Time after time one philanthropist after another has resolved to put an end to the woes of the sempstresses by eliminating from the trade the obnoxious "middleman," who is supposed to put into his own pocket so unfair a proportion of the money paid for the making of shirts. The universal experience of all who have initiated undertakings of this character has been that the attempt to carry on the manufacture of shirts of the same description as those turned out by the majority of the sweaters, while paying to the workers wages materially superior in amount to those paid by the sweaters, is one which, if conducted upon commercial lines, is doomed to meet with certain failure. It is obvious that by providing work-rooms, or machines, or both, free of charge, by making the women a present of the services of an honorary forewoman, by inducing benevolent acquaintances to give large orders for goods at prices above their market value, it may be possible to increase to an appreciable extent the wages received by the workers. But this increase is neither more nor less than charity. From the moment that an experiment of this kind begins to be conducted upon business principles, its managers find themselves compelled to reduce their wage list, and to become, in their dealings with their workwomen, little, if at all, more generous than those very middlemen whom they had hoped to oust from the trade. The fact of the matter is, that the price paid for the making of shirts and other similar articles in London, is kept down to its present low level by the competition of women living in places in which the cost of the necessaries of life is lower than in our metropolis—in Ireland, in Germany, or in Switzerland, from all of whch countries a large importation of ready-made underlinen is carried on. Under these circumstances, while the profits made by the sweaters in this trade are so small as to constitute only the most meagre remuneration for the duties of organisation and superintendence performed by these much-abused individuals, the wages received by the workers are, and must be, barely equal to the cost of subsistence. It must be remembered that very many of these sempstresses do not require to make a living out of the price of their labour, being in great part supported by their parents or their husbands. Working, as they do, merely for pin money, these more fortunate women bring down the rate of wages to a point at which these wages become inadequate to provide even the barest necessities of life. As for the women whom circumstances compel to look to the shirt-making for a livelihood, these unhappy beings are only able to keep body and soul together by working from dawn till night is far advanced, when, worn out by their cruel task, they are obliged, reluctantly, to snatch a few brief hours of repose. Hard, indeed, as is the lot of these sempstresses, it is one for which there exists, under the actual conditions of society, no hope of amelioration. By the inexorable law of supply and demand, these toiling thousands are doomed to a life of misery, from which there is no escape on this side of the grave.

"The world's hard pressed;
The sweat of labour in the early curse
Has (turning acrid in six thousand year
Become the sweat of torture."

The question of wages is, in truth, the most important of all the difficult subjects which at

the present moment engage the attention of thoughtful men. In relation to this question it is hoped that one thing, at any rate, will have been made clear by the considerations which have been advanced. The responsibility for the grave and manifold evils which are attendant upon the overcrowded state of the labour market cannot with fairness be fastened entirely upon one class of employers, or upon one method of employment. The price of labour in this country is and must be regulated by the price of labour in those countries of the world in which this price is the lowest.

Any attempt to raise the price at present paid as the remuneration of the worker is met at the outset by the question whether a higher wage-standard, accompanied, as it must be, by an augmented cost of production, might not in all likelihood enable our continental rivals to outstrip us in the race for commercial supremacy, and by causing a depression in our commerce, greater even than that which at present exists, throw out of employment large numbers of English operatives. We cannot, for example, afford to incur with equanimity the risk of losing our export trade in ready-made clothing, the value of which, as Mr. Burnett reminds us, amounted in 1885 to £4,161,150, and in 1886 to £3,902,211. Whatever steps we take in relation to the tailoring industry, we must be careful not to make a gift of our exports of slop clothes to Germany, which already carries on a considerable foreign trade in these articles, and which, while her protective system excludes English materials from the German market, would be only too ready to supplant us in all the markets of the world by the substitution, for English goods, of garments made in Germany by German cheap labour, and of German cloth. To take another instance from among the sweated industries, we may examine the position of the labour-market in the boot trade. If the workshop of every sweating boot-finisher in London were closed to-day, the price paid for the labour employed in finishing boots would, nevertheless, remain at its present figure of about 3¼d. per hour. The only difference that would result from an enforced abolition of this industry in East London would be an increased importation of articles in every way identical with those at present produced in Spitalfields, articles produced by labour performed in France, and remunerated at a rate at least as low as that which rules at this moment in ouɹ sweated boot-trade. This is a statement, the truth of which is proved by the evidence of the official returns. Prior to the year 1884, boots and shoes (of the same description as those now manufactured by our sweated boot-finishers) were imported into this country in large quantities from abroad, chiefly from France. Since the development of the sweated boot-trade, which, within the last few years, has grown up in East London, this importation has been reduced in amount by more than one third. The exact figures (which may be of interest) are as follows:—

Number of dozen pairs of boots and shoes importep into England from France.

1884.	1885.	1886.
53,437.	44,632.	39,706.

It appears to be beyond doubt that the decrease in the importation of French "sew-rounds" and ladies' boots, is in a large measure attributable to the fact that these goods are now being manufactured by the Jewish boot-finishers of East London. Far be it from my intention to suggest that the conditions under which the sweated boot trade is carried on afford cause for unmixed satisfaction, or to deny that 3⅓d. per hour is a rate of remuneration, the payment of which to any workman in any country, though it may be inevitable, is none the less a deplorable necessity. At the same time, it is proper to point out that, since cheap boots must, under existing circumstances, be made by cheap labour in some part of the globe, it is worthy of consideration whether it is not to the advantage of the inhabitants of this country that these boots should be so made in England rather than abroad. The almost unskilled labour of the Jewish boot-finishers, who work eighteen hours a day for a fraction over 3d. a hour in East London is, it is important to remember, subsidiary to the labour of English workmen—men whose work is skilled and whose wages are high. To say nothing of the English tanners, who prepare whatever English leather may be used in the manufacture of these boots and shoes, we must not forget that finishing is only one among the large number of processes which are involved in the manufacture of these articles. If we were in future to supply by importation all our requirements in respect of cheap boots and shoes, this alteration in the boot-making industry would throw out of employment a large number of Englishmen now engaged as boot-clickers at wages averaging from 28s. to 35s. per week

and of Englishwomen who now earn a weekly wage of about 14s. as closers, the hours of work in the case of both closers and clickers averaging ten in the day.

It is our duty to secure for the employees of the sweater the provision of sanitary and sufficient accommodation. The over-crowded and unhealthy dens in which the work of many sweaters is at present carried on must be reformed; if needful, reformed out of existence. As to the wages of the sweated operatives, it is to be feared that it will be difficult, if not impossible, without a complete revolution in our social and industrial organisation, permanently to raise, to any considerable extent, the remuneration of labour, in which the element of skill is so deficient as in that of these unfortunate workpeople.

Facts are stern things, and the consequences which result from the excess of the supply of unskilled labour over the demand for that commodity, are among the sternest of the social facts by which we find ourselves confronted at the present day. The problem, which requires to be solved in relation to cheap labour, has recently been propounded with that singular lucidity of exposition which we all admire in Professor Huxley, in words with which this paper shall be brought to a conclusion.

"I am aware that one great factor in industrial success is reasonable cheapness of labour. That has been pointed out over and over again, and is in itself an axiomatic proposition. And it seems to me, amongst all the social problems which face us at this present time, that the difficulty is how to steer a clear course between two horns of a dilemma. One of those is the constant tendency of competition to lower wages beyond a point at which man remains as man—below a point at which decency, and cleanliness, and order, and habits of morality and justice can reasonably be expected to exist. And the other horn of the dilemma is the difficulty of maintaining this point consistently with success in industrial competition. I have not the remotest conception how this problem will eventually work itself out; but of this I am perfectly convinced, that the sole course compatible with safety lies between these two extremes, between the Scylla of successful industrial production with a degraded population on the one side, and the Charybdis of maintaining the population in a reasonable and decent state with failure in industrial competition on the other side."

DISCUSSION.

Mr. J. P. (Lakeman, H.M. Inspector of Factories) said he was interested in this question of sweating, whether applied to the trade of tailoring, shoemaking, or shirtmaking, a practice which, owing to economic circumstances, was not confined to the Jews, but had spread amongst the Gentile community. He had been occupied for some years in studying, and writing upon, the enormity of this system, which had very largely developed from the time of its inception some 40 or 50 years ago, when large profits were made, a state of things which led to the introduction of foreigners into England, either by fair promises, or from what they heard from their friends. The great fact remained that England, and especially London, had become an overgrown colony of these Jewish tailors, and the development of the trade and the influx of people had caused such a great sub-division of labour, that the master who owned the material must eventually get the best of the bargain. He agreed with Mr. Schloss as to the unsanitary conditions under which the work was carried on, and it would cause a shudder were he to relate all that he had seen. He had often witnessed, in cases where the factory inspectors had no power to interfere, scenes which ought not to be permitted. Some remedy was required, and from the great interest which, of late, this subject had occasioned, he had no doubt that, sooner or later, some remedy would be applied. It was quite true, as had been stated, that the factory inspectors were in many cases powerless. This was the case where the work was what was called domestic, or where only adults were employed; in these cases the whole control rested with the local authorities. The great question, after all, was the wages question, and as long as there was an increase of population, a rigid sub-division of labour, and immigrants to fill any void, so long would the price of tailoring and shoemaking be kept down, even lower than it was at present. The biggest people made money; those who were not properly called sweaters could make a long purse if trade was good, but the poor man who employed three or four workpeople in horrid dens, where they worked some 16 or 18 hours a day, did not gain very much. Were it not for the Act about the labour of women, many of them would be working the same hours, and for no more wages than they obtained for 10½ hours. If those hours of labour could be reduced, a great improvement in the condition of the workpeople would result.

Mr. Adolphe Smith said some four years ago he prepared a special report for the *Lancet*, on sweating as carried out in the East-end of London, and some years previously on tailoring in the West-end of London, and during the course of these investigations he came across one or two matters which had not been alluded to in the very able, but in its conclu-

sions somewhat disappointing, paper they had heard. In one place in the East-end eighteen persons were working in a room measuring 8 yards by 4½, and not quite 8 feet high. The first two floors were let out to lodgers, and the whole place was in a very dilapidated condition, and yet the tailor who hired that abode showed a receipt for £17 in payment of one quarter's rent. It seemed preposterous that £68 should be charged for the use of a house which was literally falling to pieces, and contained only six rooms. The temperature of the room in which these eighteen persons were at work was not only very close, but the air was full of dust from the wool and cloth, and it was not surprising therefore that so large a proportion of working tailors broke down from diseases of the respiratory organs. To further complicate the matter, therefore, there was the question of the housing of the poor, and the extremely high rent charged for these sweating dens made it still more difficult for the sweater to make both ends meet. He was glad that the sweaters' difficulties had been brought before the meeting, for it was altogether unfair to blame one set of men for the entire system. It had been well shown in the paper that by competition wages were reduced almost to starvation point. By the competition of the employers against one another they were obliged to grind down the workpeople, while the competition between merchant tailors reduced the gains of the sweaters themselves. It was competition all round which produced the state of misery they were all lamenting. Mr. Schloss seemed to think that if the workers possessed skill, these starvation wages would not exist; but it appeared to him it was not skill itself, but its rarity which was important. Take for instance the very ill-paid City clerks; they had education, and were more skilled in their way than many wage workers who were fairly well paid. The only thing which prevented starvation wages was exceptional capabilities, and the moment a person ceased to be an exception the salary would fall. Even philanthropic and co-operative efforts had proved of no avail to meet this difficulty, and the Factory Act had been of very little service. He could not see why the Factory Act should be so clumsily applied, although he made no reflections on the individual inspectors, whose hands were tied by the red tapeism of the law. Why was it not carried out like other Acts which were passed to prohibit criminal practices. Mr. Lakeman was well known throughout the whole of the East-end, and the moment he appeared the signal was given, so that by the time he reached the place he could find little or nothing to denounce. He would defy Mr. Lakeman to appear anywhere in the East-end without being at once recognised, unless he went disguised. Why should not some kind of a detective force be employed in this matter? One point he wished specially to insist upon as of importance, was the question of high rents, and next, that the faults of the sweating system were due, not to the working man, the sweater, or to the merchant tailor, but to the entire competitive system. As long as commerce was managed upon the present basis of every one for himself and the devil take the hindmost, he did not see how this misery could be avoided. As for emigration, there were about 30,000 foreigners in the East-end, but we sent out 250,000 of our own countrymen to foreign parts. If they were to return we should be worse off than by continuing to permit the introduction of a few Polish Jews.

Mr. PARNELL said the reader of the paper had merely alluded to one trade in which sweating was carried on to as great an extent as in the tailoring, although perhaps not to such disastrous results, and that was cabinet-making, the trade to which he belonged. The way in which that trade was now being conducted was this. When a gentleman required an article of furniture he went to a presumed manufacturer; he had a sketch made of the article he required, and the manager sent to the foreman to ask what he could make it for. Then if the order was given, it was sent round to certain trade shops, which the workmen termed sweating shops, and which had the reputation of making such goods in a decent-looking style for a less price than they could be made in the ordinary way, and the one which sent in the lowest estimate got the order. This system was of no benefit to the customer, and he maintained that the man who took in work which he did not execute himself, but gave it out to someone else to do at a lower price, was a sweater. He was the cause of the working man getting lower wages than he would if he worked directly for the man who supplied the goods. The man working for a sub-contractor could only get his legitimate wage by working longer or harder than he would if he worked for the firm at first hand. Beyond that, again, there were sweaters inside and outside, maintained by the second sweating firm. Inside, they were generally men who employed youth and boys, paying them a few shillings for the rougher part of the work, and only doing the finer parts themselves. He agreed that if skilled men combined together, they might defy the sweater, but it was the combination, not the skill, which was effective, and the vast majority of cabinet-makers were not in combination, though the higher branches of the trade required as much skill probably as any handicraft; and thus they were robbed by two or three illegitimate profits. If work were restricted to eight hours a day, there would be employment for all the cabinet-makers who were now idle. Sweating affected everyone, not the working man only; the purchaser did not get what he paid for, but an inferior article, whilst the working man was robbed of a portion of his wages. He had known a man in his trade who had worked a whole week for 15s., though the goods he had been working on were going into the hands of some of the highest in the land.

Mr. OLIVER J. WILLIAMS rather differed from Mr. Smith, who spoke of a wholesale change by legislation, and thought they should rather trust to time and moderation. He knew more of country than of London life, and in the country he knew many poor families who were immensely helped by the system of working in their own homes. With regard to the sanitary aspect of the question, he did not think enough had been said as to the powers which the local authorities possessed, but they too often neglected their duty, either from want of proper supervision, or because they were local, and did not intervene as they ought. This was a well-known fact in the country, and the same thing would apply to the housing of the poor. One remedy, which would be comparatively easy of application, would be to get the poor into better dwellings in the suburbs, where the same wages would serve their purpose better, and, being at a cheaper rent, they would be much better off altogether. The chief causes of the evil were the increase of population, and the competition of those who only worked for what had been called pin money, as against those who had to earn their bread and cheese, and that could not be remedied by legislation. Technical education was one of the remedies which, he held, the poor would appreciate, and another important one was emigration.

Mr. F. S. MIERS could hardly agree with Mr. Schloss that what he had so well described could not be called a system. His impression was that the sweating as now carried on was a system, and the elements of that system were the inordinately long hours, the extremely low wages, the insanitary conditions, and the employment not only of unskilled labour, but of people who were almost incapable of making themselves understood by anyone but the sweaters, and who were thus at their mercy. If sweating were not considered as a system in its entirety, it would be impossible to deal with it, since it would become a mere question of division of labour and of the shop hours movement. The system as it prevailed in London was one of cruelty, under which the poor victims were forced to work, and being known to all the employers, the moment they did anything obnoxious they were turned adrift, and no one else would employ them. The only remedy he could suggest was the registration of all workshops, and an extension and enforcement of the Factory Acts.

Miss SCRIMGEOUR said she had assisted in carrying on a shirt-making business, and the result of her experience was that the profits made out of that trade did not allow of paying the workers much more than the deplorably low rate of wages they received.

Miss MEARS (secretary to the Upholsterers' Union) corroborated what had been said by Mr. Parnell, from what she had seen and heard, her father having been a cabinet-maker. She also spoke of the manner in which large houses purchased articles of furniture from men who made them at home and took them round to the shops, offering them at prices which barely paid for the material and labour. The men were kept waiting on a Saturday until it was too late to go elsewhere, so that they were almost obliged to accept anything which was offered in order to pay the men who had worked for them. The sooner this horrible system was done away with the better it would be for both men and women.

Mr. COLIN MACKENZIE thought he could throw a little light on the extreme competition in the shirt trade. When travelling in the United States he was thrown a good deal in the way of a man who was travelling in this trade for a large New York house, and after getting somewhat intimate with him, heard a good deal about the mode in which the business was carried on. He found that his firm had recently been doing a good business with some London wholesale houses, and on inquiring how they could compete with the low wages in England, found that they had made a contract with all the Houses of Correction in New England, supplied them with machines, and got the work done at their own prices, and in this way they were able to under-sell English manufacturers in the London market. He found on getting to New York that the firm in question was one of the largest in that place, and that the head of it lived in grand style in one of the principal German cities. Until they could control supply and demand, and either increase the demand or diminish the supply, without doing injury to individuals, they could not hope for any real remedy.

Mr. B. KISCH asked if the evils which had been so clearly pointed out existed in other countries as well as in our own, and if so, whether it did not tend to show that they were inherent in the nature of things. He presumed England was not the only country in which large factories for the supply of the necessaries of life existed, and it would be interesting to know if the operatives elsewhere were as badly or worse off than our own. If they were better off, we should next inquire whether this was due to general causes, to their own temperance or thrift, or to superior legislative protection. After all, the great law of supply and demand reigned supreme.

Mr. O. WILLIAMS said that from a short residence in both Italy and Russia, he could say that in both those countries the same evils existed to an even greater extent than here.

Mr. MOCATTA said he did not profess to know anything of the sweating system, though he knew a great many of its victims. One thing, however, appeared to him quite certain, and that was that legislation could do exceedingly little to mend matters. It could do something, however, in

sanitary matters, and that ought to be done, for the insanitary state of the places in which these industries were carried on was a standing menace to not only the unfortunates who worked there, but to the whole of society. If there were masses of pestiferous dwellings in the midst of our large city, the diseases which arose would be propagated by germs through the air, and the most magnificent dwellings would be infected as well as the lowest. The very fact of tailoring being one of the trades most largely affected by the sweating system, at once suggested that if garments were made under conditions so detrimental to health, they would carry with them the germs of disease, and, in fact, hardly any better means of spreading infection could be invented. He did not believe in the *reductio ad absurdum* of an Englishman's house being his castle; it might be his castle, but he ought not to be allowed to make it a source of disease and suffering to his neighbours. The sweating system was merely the outcome of the law of supply and demand. The country was unfortunately too full; cities were enormously too full; and the capital was terribly too full; and as he had said hundreds of times, unless some large and comprehensive system of emigration were devised, whereby thousands if not millions of our working population were sent to people our Colonies, which must be a great blessing to this country, but which were no blessing at all unless they were inhabited, the evils which were now complained of were trifling in comparison to what we should have to endure in the course of twenty or thirty years. He hoped the attention of the Legislature would be directed to the insanitary conditions under which this work was carried on, and also that both the Legislature and Society would devote attention to sending the unfortunate persons who could not find a living here to places where, instead of being a menace, they would be a support and source of strength.

Mr. REED said he belonged to the building trade, which had not been alluded to hitherto, but in which also the sweating system, as he understood it, prevailed; for there, too, the middleman was making himself felt. He had often noticed how builders failed to carry out the specification on which they were working, and if they were discovered, threw the blame on the workmen. One gentleman advocated sending the working classes who were in such a degraded condition to the Colonies to better their condition, but that was useless; the whole economic question required to be studied. No doubt the towns were overcrowded, but the country was depopulated. It was the question of capital which would have to be fought out, and until that was done the workers would never be benefited. They talked of bad workmen, but whose fault was it that there were bad workmen? He was of the same opinion as Ruskin, that you should unmake the bad workman. Even the bad workman must live; they were all born to the earth, and had an equal right to enjoy its fruits. As Ruskin said, they did not object to pay the bad lawyer, bad doctor, or bad parson, and why object to pay the bad workman? He was pleased to see so many of the middle-class taking an interest in this question, and he hoped they would inquire into it, and give the working-classes their assistance in helping to solve it.

Mr. J. A. MARKS said the question seemed to have been made during part of the discussion a good deal of a sentimental one, but everybody—working-classes and others—when they wanted any article, always endeavoured to obtain it at the lowest possible price. The employer found that goods were imported from abroad very cheap, and immediately set to work to produce them as cheaply as the foreigner. The only way in which this could be achieved was by the sub-division of labour, which reduced skilled labour to a series of operations of unskilled labour. Unskilled labour, where there was a large population who lived in expensive dwellings, had to compete with the foreigner, whose low rate of living, thrift, and other characteristics, all gave him an advantage, and there was also less interference in other countries with industrial operations. The question of free trade here came in, and that question would have to be faced. There was quite enough produced in the world to supply all, and the only question was whether you could bring the produce to the consumer better from abroad or in England. It was not a question of social revolution but of common sense. No man would pay 1s. for what he could get for 6d.; the 1s. man had to compete with the 6d. man, and this competition produced division of labour, which, again, led to unskilled labour being used in place of skilled. Sanitary conditions should be insisted on either by local or imperial authority; he should think the latter, because the local people were always more or less interested in the matter.

The CHAIRMAN than proposed a vote of thanks to Mr. Schloss, who had devoted a deal of time and study to this important question, and the Society was much indebted to him for bringing it forward.

The vote of thanks having been passed,

Mr. SCHLOSS said, some points which it was thought had been omitted would be found in the printed paper, and many others were not there for the simple reason that it was already too long. He would, however, reply to the question of Mr. Kisch, whether there was sweating in other countries, by saying that there was in nearly all. The sweating system in America had been very well described in a novel, "The Prisoners of Poverty," by Helen Campbell, the pictures in which were accurately drawn from life, and matters there were every bit as bad as here. Wages had come down to bare subsistence, and lower they could not get anywhere.

The same thing occurred in Berlin and Paris. Wherever you went the wages of low-class labour were miserably low, and he did not quite see how, without raising wages all over the world, or at any rate, in those countries which were in direct competition with us, it was possible to raise them at home.

Miscellaneous.

NON-INFLAMMABLE WOOD.

At the requisition of the Belgian Minister of Public Works, M. Boudin and M. Donny, professors at the Ghent University, have conducted a series of experiments and investigations in connection with rendering wood uninflammable. The following *résumé* embodies the conclusions at which they arrived, as set forth in their report to the Minister.

Although wood cannot practically be rendered so fireproof as not to be destroyed by heat, it is very possible to deprive it to a considerable extent of the property of catching and communicating fire; and to this end it is sufficient to coat the wood with a suitable composition.

It is not, however, sufficient that this composition or substance possess in a high degree the property of rendering wood uninflammable; it must also fulfil other conditions. The treatment must not involve an expense out of proportion with the purpose to which the wood is applied, nor should the process be such as to delay the rapid execution of works. Nor should the substance employed be liable to attack any metal parts which it may be necessary to use with the wood.

The process should also be of easy application, with a brush, for instance, the only manner in which it can be applied to existing structures. The wood thus coated should present a neat and tidy appearance, and should also be capable of receiving a coat of ordinary paint over the fireproofing composition; nor should one or the other coat be subject to alteration after a moderate lapse of time.

If, instead of coating, the method of injection be employed, certain substances, notably chloride of calcium, should be rigorously excluded, because they would keep the wood constantly damp. The injection method is easily applied to small articles by simple immersion; and it is preferable that the composition or solution be hot, if not boiling. The possible diminution of strength due to all injection processes should also be taken into account, although the results of experiments are not conclusive on this point.

It follows from the above considerations that wood cannot be rendered incombustible, or more strictly speaking, non-alterable by heat; but its non-inflammability may, to a considerable extent, be ensured, so as to preserve buildings from a limited and temporary fire, at any rate until assistance arrives. It is, however, hopeless to expect a building encumbered with inflammable substances to pass through such a test uninjured.

The methods of preserving wood against fire are of two kinds: the injection of saline solutions, and the application of a paint or coating. The former appears but little practical; and, indeed, short of proof to the contrary, it must be considered dangerous in the case of wood of large dimensions. This system is, however, applicable to small pieces of wood. Of all the substances recommended, a concentrated solution of phosphate of ammonia is undoubtedly the best, the use of this substance, notwithstanding its high price, possessing such great advantages that it should be employed in all cases where expense is no object.

In the majority of cases, however, coating with a brush is the only practical solution of the question; and the substances most to be recommended for use in this manner are cyanide of potassium and asbestos paint.

Correspondence.

THEATRES AND FIREPROOF CONSTRUCTION.

Mr. Lionel Van Oven writes:—"I should like to see the attention of the Society of Arts drawn more to the question of the safety of audiences than of the buildings containing them. I therefore suggest to the Society to use its influence with the governing bodies of the country, whether imperial or local—1st. To visit every theatre and place of public resort (places of worship included), and to license each for the number of people for whom it may be considered that there is sufficient accommodation, and means of exit in case of fire or other panic. 2nd. To formulate a table of regulations for the safety of audiences as regards numbers, lights, gangways, staircases, exits, and other precautions for safety. 3rd. To make it compulsory for these regulations to be plainly printed and hung in all vestibules, so that the public may read them, and from time to time see that they are not neglected. 4th. That for every case of proved negligence or infringement of these regulations, especially as to numbers, the managers of the theatre or building shall be held responsible, and subject to a heavy fine."

Mr. W. Winn writes:—In the case of fire in theatres, too much reliance should not be placed upon the firemen being in readiness to quell the flames, no matter how complete the machinery under

their control and at their command may be; but the recent fires convince me that a greater safeguard for the public safety lies within the power of theatre managers and others, and that is, in the event of a scare, be it from fire or other cause, a certain number of cool-headed *employés*, such as waiters, scene-shifters, and others, should have allotted stations amongst the audience, and be instructed and trained to stand by their posts, and by coolness and tact, to appease the excitement and scare amongst the people. Four or five men so employed on each tier could exert much influence to prevent the fatal rush of the people, which has proved more disastrous than the rush of the flames.

Obituary.

GEORGE GODWIN, F.R.S.—Mr. Godwin, who had been an active member of the Society of Arts for over thirty years, died at his home at South Kensington, on Friday, 27th inst. He was born in January, 1815, and early attached himself to the architectural profession, of which his father was a member. At the beginning and end of his career he was honoured by medals awarded to him by the Royal Institute of British Architects. In 1835, he received a medal for an "Essay on Concrete," and in 1881 he received the Queen's Gold Medal. In 1838, he published a work on the "Churches of London," and in 1839 he was one of the founders of the Art Union, and became its honorary secretary. In 1844, he became editor of the *Builder*, a post which he held until a few years ago. Mr. Godwin took a special interest in the improvement of the insanitary condition of the country, and he wrote several books on the subject. He was one of the jurors of the Great Exhibition of 1851, and he took a prominent part as one of the judges in the Art-Workmanship competitions of the Society of Arts, established in 1863, and continued until 1871. He took the chair at the evening meetings on several occasions, and at the time of his death he was a member of the Committee of the Applied Art Section.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 8.—"The Continuation of Elementary Education." By W. LANT CARPENTER, B.A., B.Sc. THE RIGHT HON. SIR LYON PLAYFAIR, K.C.B., M.P., F.R.S., will preside.

FEBRUARY 15.—"Type-writers and Type-writing." By JOHN HARRISON. SIR HENRY THOMPSON, F.R.C.S., will preside.

FEBRUARY 22.—"The Technical Education Bill." By SWIRE SMITH. PROF. SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

FEBRUARY 7.—"British Columbia." By HENRY COPPINGER BEETON, Agent-General for British Columbia.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

FEBRUARY 14.—"Principles of Design, as applied to Bookbinding." By HENRY B. WHEATLEY. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., will preside.

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

FEBRUARY 10.—"The Work of the Afghan Frontier Commission." By CAPTAIN MANIFOLD, R.A. J. M. MACLEAN, M.P., will preside.

FEBRUARY 24.—"Facts regarding the religions of India, and their influences on the moral progress of the people." By SIR WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D. The EARL OF NORTHBROOK, G.C.S.I., will preside.

CANTOR LECTURES.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE II.—FEBRUARY 6.—Mode of reproduction of yeast.—By sprouting.—By endogenous division.—The latter term defined.—Ascospores.—Conditions necessary to their formation.—Conditions of nutriment, of temperature, and of time.—The method of production explained.—Classification of saccharomyces according to their power of producing ascospores.—Those which form them.—Those which do not.—Critical examination of the various species from this point of view.—Saccharomyces and torulæ.—Analytical table of ascospore formation among saccharomyces.—Its practical significance.—Pure yeast secured and maintained by reference to it.—Impossibility of identifying species of saccharomyces except by ascospores.—*S. Cerevisiæ* capable of assuming typical forms of other species and conversely.—Top and bottom yeast.—Their resemblances and differences.—Character of beer determined by species of saccharomyces employed.—The essential differences explained.—Conditions necessary to healthy multipli-

cation by sprouting.—Primary considerations affecting the question.—Fungal cellulose.—Protoplasm.

Professor Herkomer's Lectures.

The second and third lectures on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R.A., on Thursday evenings, February 9th and 16th.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. Gordon Salamon, "Yeast, its Morphology and Culture." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. H. E. Armstrong, "The Alkaloids, a review of the synthetic methods of preparing 'Closed chain' Azo-carbon compounds." 2. Mr. Lewis T. Wright, "Studies in Coal Distillation." (i.) The influence of the distillation temperature on the quality of the Tar; (ii.) its influence in the Sulphur Compounds other than Sulphuretted Hydrogen occurring in Coal Gas; (iii.) its influence on the yield of Ammonia from Coal.

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. S. B. Saunders, "Railway Fences and Boundaries, and the Question of Substituting Iron in lieu of the Materials now used."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Resumed Discussion on Mr. R. Nevill's paper, "The Auditorium of a Theatre."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Mr. Maspero.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The Asmonœans."

Tuesday, Feb. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Henry Coppinger Beeton, "British Columbia."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture IV.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. A. C. Hurtzig, "The Alexandra Dock, Hull."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "Third Contribution to the Herpetology of the Solomon Islands." 2. Mr. Arthur G. Butler, "Descriptions of some New Lepidoptera from Kilima-njaro. 3. Mr. Frank E. Beddard, "Certain Points in the Visceral Anatomy of the Lacertilia." 4. Mr. D. D. Daly, "The Birds'-nests Caves of Northern Borneo."

Wednesday, Feb. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Lant Carpenter, "The Continuation of Elementary Education."

Meteorological, 25, George-street, S.W., 7 p.m.

Geological, Burlington House, W., 8 p.m. 1. Mr. A. Smith Woodward, "Some Remains of *Squatina Cranei*, sp. nov., and the Mandible of *Belonostomus cinctus*, from the Chalk of Sussex, preserved in the Collection of Henry Willett, Esq., F.G.S., Brighton Museum." 2. Mr. George Jennings Hinde, "The History and Characters of the Genus *Septastræa*, D'Orbigny (1849), and the Identity of its Type Species with that of *Glyphastræa*, Duncan (1887)." 3. Mr. E. Wethered, "The Examination of Insoluble Residues obtained from the Carboniferous Limestone at Clifton."

Microscopical, King's College, W.C., 8 p.m. Annual Meeting. Presidential Address by Dr. Dallinger.

Pharmaceutical, 17, Bloomsbury-square, W.C. 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Thursday, Feb. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Extra Lecture.) Prof. H. Herkomer, "Etching and Mezzotint Engraving." (Lecture II.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. G. J. Romanes, "Primitive Natural History."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert Parry, "Early Secular Choral Music." (With illustrations.) Lecture I.

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr Gilbert Kapp "Alternate Current Transformers with special reference to the best proportion between Iron and Copper."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, Feb. 10 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Captain Manifold, "The Work of the Afghan Frontier Commission."

United Service Inst., Whitehall-yard, 3 p.m. Captain H. S. Wilkinson, "The Practical Value of the Kriegspiel."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. W. H. Preece, "Safety Lamps in Collieries."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. H. Medway Martin, "Arched-Ribs and Voussoir Arches."

Astronomical, Burlington-house, W., 3 p.m. Annual General Meeting.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Paper by Mr. Sidney L. Lee.

Saturday, Feb. 11...National Smoke Abatement Institution (at the House of the Society of Arts), 8 p.m. Mr. Alfred E. Fletcher, "Town Smoke and House Warming."

Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Annual General Meeting. 2. Mr. T. Pelham Dale, "The Limit of Refraction in Relation to Temperature and Chemical Composition."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture IV.)

Correction.—Page 234, col. 2, in Mr. E. C. Robins's remarks, "a wooden beam say four inches square," should read "a timber girder fourteen inches square."

Journal of the Society of Arts.

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FRIDAY, FEBRUARY 10, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the course on "Yeast, its morphology and culture," was delivered by Mr. A. Gordon Salamon, on Monday evening, 6th inst. The lecture was illustrated by a fine series of microscopes, lent by Messrs. R. and J. Beck, of Cornhill, in which objects were shown by means of immersion lenses of high powers.

The lectures will be printed in the *Journal* during the summer recess.

LECTURES ON ETCHING AND MEZZOTINT ENGRAVING.

Professor Hubert Herkomer, A.R.A., delivered the first of his lectures on "Etching and Mezzotint Engraving," on Thursday evening, 2nd inst., and the second lecture on the 9th inst.

The lectures will be printed in the *Journal* at a later date.

BOOKBINDING EXHIBITION.

An Exhibition of specimens of historical and modern bindings in blind tooling, gold tooling, and cloth, will be arranged in connection with Mr. Wheatley's paper on "The Principles of Design as Applied to Bookbinding," to be read at the meeting of the Applied Art Section, on Tuesday evening next.

The Exhibition will be opened on Tuesday evening, 14th inst., and will be continued during the week. Hours—Wednesday and Thursday, 11 till 9; Friday and Saturday, 11 till 6. Admission free on presentation of visiting or trade card.

Proceedings of the Society.

NINTH ORDINARY MEETING.

Wednesday, February 8th, 1888; the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Collins, John, Analytical Laboratory, Bradford-buildings, Mawdsley-street, Bolton-le-Moors, Lancashire.
King, Frank, 38, Chesilton-road, Fulham, S.W.
Ransome, Allen, Stanley Works, King's-road, Chelsea, S.W., and 26, The Boltons, South Kensington, S.W.
Smith, Grimston Abel, Romford, Essex.
Vincent, Frederick Gillmore, 9, Southwark-bridge-road, S.E.

The following candidates were balloted for and duly elected members of the Society:—

Baxter, William Henry, The Lawn, Brixton-hill, S.W.
Collett, John Martin, 6, Brunswick-square, Gloucester.
Corke, Henry Charles, 178, High-street, Southampton.
Dunlop, Charles, 1, Ashbourne-grove, East Dulwich, S.E.
Ferguson, Reginald, 44, Belsize-park-gardens, N.W.
Leigh, Hon. Francis Dudley, 4, West Chapel-street, Mayfair, W., and Stoneleigh Abbey, Kenilworth, Warwickshire.

The paper was read—

THE CONTINUATION OF ELEMENTARY EDUCATION.

By Wm. Lant Carpenter.

"No country spends so much effort as ours in attempting to cure evils after they have become incurable; none spends so little in preventing their growth. If you wish to cope with the horrid life of the slums, you must begin with the children. If you want to stop the squalid pauper marriages which take place in London—often at 17 or 18 years of age; if you want to transform our beery casual labourer into an intelligent, self-respecting artisan; if you wish to fit our superabounding population to be good emigrants and colonists—you must begin with the children. Keep them at school till habits of industry and application are formed, till they get a higher ideal of life, and till they are filled with a divine discontent with the animal life of the

slums. Until you do this, Commissions on the dwellings of the poor will report in vain, the United Kingdom Alliance will preach to unwilling ears, social purity societies will yield scant results, and England will remain cursed with a degraded proletariat till doomsday."

In these vigorous and trenchant words did an eminent member of our Legislature address his fellow-countrymen through the Press last August, and they serve as a fitting indication of the tremendous importance of the subject which we have to consider together to-night —"The Continuation of the Elementary Education of our Young People," a subject before which, not only in my own mind, but in the minds of many elders among us—some of whom, alas, can no longer personally aid us with their counsel—every other educational question fades into something approaching insignificance. For I wish it to be distinctly understood that this paper deals—not with the education of one section of our children, intended, perhaps, for some particular employment, like that of my friend Sir Philip Magnus, who recently, in this room, enlightened us upon the needs of Commercial Education—but with the children of the whole mass of our population—even the very lowest.

And how do we treat our children at present? "Nobody will deny," said Lord Derby, recently, "that the years between 13 or 14 and 20 are the most important years of life." On the contrary—whatever people may say—in practice this is exactly what, in our corporate capacity as a State, we do most emphatically deny! Instead of our treating them as the most important years of life, they are the very years which the State declares to be of no importance whatever. In the same number of the *Times* that contains a report of Lord Derby's speech occurs a letter from one of its correspondents, who asks—"How is it that the 'unemployed mobs' are so largely recruited by the recent products of our School Boards, lads from 14 to 20 years of age?" Answering his own queries, he continues—"Because School Board influence stops short just when it should be fruitful of good results. There is in this country no sequential teaching, no technical teaching, no effort to carry further the listless treatment which turns out boys at 14, unready for any trade, untaught in any of the larger lessons of life or of citizenship."

Writing to me recently on the subject of the London mobs, Sir Charles Warren, Chief Commissioner of Police, observed—"It has been frequently remarked in the daily papers that very many of the mob were youngsters," and he adds an opinion which I shall presently quote, as to what, in his judgment, is the most suitable kind of school.

To the mind of anyone who seriously looks forward to what will probably be the social and industrial condition of our country a few years hence, unless certain prevailing tendencies are at once checked, what can be more deplorable than the deterioration of the children which takes place after leaving our elementary schools? Their chief educators are the street, the cheap music-hall, and the low periodical with its filthy tales. As soon as they are 13 years old their parents are allowed to work them in factories for ten hours a day, and what is the consequence of all this? Let Mr. Besant answer.*

"Boys and girls at thirteen have no inclination to read newspapers; after their day's work and confinement in the hot rooms they are tired; they want fresh air and exercise. To sum up: there are no existing inducements for the children to read and study; most of them are sluggish of intellect; outside the evening schools there are no facilities for them at all; they have no books; when evening comes they are tired; they do not understand their own interests; after a day's work they like an evening's rest. The street is always open to them; here they find the companions of the work-room; here they feel the swift strong current of life; here something is always happening; here there are always new pleasures; here they can talk and play unrestrained, left entirely to themselves, taking for pattern those a little older than themselves. As for their favourite amusements and pleasures, they grow yearly coarser; as for their conversation, it grows continually viler, until Zola himself would be ashamed to reproduce the talk of these young people."

Under our present education laws, what is the usual history of a child among the working classes? He or she leaves the elementary school as soon as the "Exemption-standard" is passed, that is to say, at an age which is constantly becoming earlier as the children are more quickly passed through the various standards. This exemption-standard, being under the control of the various School Boards, varies in different parts of England. In many rural districts, and in a few large towns, like Leicester and Norwich, it is as low as the fourth, in many towns it is the fifth, while in London it is the sixth. Let us look at the state of things in Wolverhampton, which, in some respects, may be regarded as a typical

* *Contemporary Review*, March, 1886.

town, and where passing the fifth standard exempts children from further attendance. In 1884-5 the average age at which this was passed was 11 years 7 months, but in 1885-6 it was 11 years exactly, that is, the average age had positively lowered 7 months in a year's time. In this latter year only 78 children were in Standards VI. and VII., out of 2,657 children examined; hence, not 3 per cent. of the children attended school after passing the fifth standard, *i.e.*, after 11 years of age! In most towns the average leaving age is about 12, in London it varies from 12 to 13; in very few cases is it above 13. Hence, speaking broadly, it may be asserted that the school life of the English working man's child comes to an end at 12 years old; of the vicious character of the influences which "educate" it subsequently, at this critical time of life, while the character is being formed for good or ill, I have already spoken.

The following Table shows the extremely small proportion, and the yearly decrease even in that, of children above 14 years of age in our elementary schools:—

Year ending August.	Total schools inspected.	Rate of grant per scholar.		Number on Register.		Proportion of total above 14
				Under 14.	Above 14.	
		s.	d.			per cent.
1880	17,614	15	$5\frac{3}{4}$	3,881,466	44,358	1·14
1881	18,062	15	$8\frac{1}{4}$	3,999,635	45,727	1·14
1882	18,289	15	$10\frac{1}{2}$	4,134,045	45,567	1·10
1883	18,540	16	$1\frac{1}{4}$	4,230,557	42,747	1·00
1884	18,761	16	$7\frac{1}{2}$	4,297,298	40,023	0·93
1885	18,895	17	0	4,372,728	39,420	0·90
1886	19,022	17	$2\frac{1}{2}$	4,465,781	40,044	0·89

Average attendance, 74·33 per cent.

What evidence has been given on this subject of Exemption-standard before the Royal Commission appointed to inquire into the working of the Elementary Education Acts of England and Wales, which I shall hereafter refer to shortly as the "Royal Commission"? In the third report (to which I shall chiefly confine my observations to-night), out of fourteen influential witnesses who were questioned on the subject, and replied in 120 answers, there was not one who, in some form or another, did not advocate a raising of the exemption-standard, whether in country or town schools. The only doubt expressed was by a witness from Leicester (where Standard IV. exempts), who would like to see it higher, save for the hardship to the parents. Surely, it may well be asked in a matter of this kind, does not the welfare of the State, as a whole, override that of individual members of it?

What do our schoolmasters, employers of child labour, and others, say to the practical effect of this early exemption? Many Board school teachers have frequently spoken to me and to my friends in the strongest terms of the lamentable change for the worse, wrought upon the minds and bodies of some of their fairest scholars in a year or two after they have left school. It is no uncommon thing to find a child that has passed Standard V. in school, unable even to pass Standard III. a few months after leaving it. An inspector in a country town in Dorset was told by the chairman of the School Board, who was also chairman of Quarter Sessions, "A lot of these bright, sharp boys that you have seen to-day will leave, because their parents know that they can leave, and in three or four months' time they will be coming before me, as chairman of the Quarter Sessions, for robbing orchards and things of that sort, and I shall have to punish them for what is really not the boy's fault." In a very powerful letter in the *Manchester Guardian* last September, the writer says, "A foreman in a large mill informs me that he makes it a point to ascertain how far the boys and girls employed about him are keeping up their school knowledge. He finds that only 4 per cent. are making any progress, and that these go to night schools; the others, 96 per cent., are relapsing into their primitive ignorance, &c." It is greatly to be feared that this represents the proportion fairly in most large towns; at any rate, it does do so in those in which inquiries have been made into the question.

What, therefore, does this imply? First, we build up at enormous expense a colossal system of primary education, costing the country many millions annually, and then we allow the results of it to be very largely wasted, if not utterly lost. We are doing the work of Sisyphus; we are rolling up the big stone of ignorance and its attendant evils, and when we have got it nearly to the top, we let it come down and crush us. The garden which by daily culture has been brought into such an admirable and promising condition is given over to utter neglect. We cease to educate at the most important, the most plastic, the most receptive period of life. The years between 13 and 17 are the critical and formative years for every human being. Then the physical

energies of the body, as in a spring tide, thrill out into every limb and organ; then, if ever, is there need for education to guide, restrain, and inspire; for these are the years in which character is formed, almost unalterably, and in these years does the need and use of knowledge first begin to be comprehended, since it quickens and directs the mind for the true understanding, the wise enjoyment, and the right conduct of life. Here then, I say most earnestly, is the paramount problem of our time in the education of the people.

But, it may be urged, is not this unavoidable? Have we any right to interfere further than we do with that birthright of every true Briton, the liberty of the subject? My reply is, that no country has ever suffered more from the abuse of individual liberty than England has done. It was from this cause that we did not get even a measure of compulsory education till long after continental nations, and we are still far behind them in the care we take of our children. Democratic government everywhere insists upon good education, and expects each citizen to fulfil his duties to the State. This is the mainspring of the remarkable movements for the education of the negro, and for that of blind and deaf and dumb young persons in America.

What then, briefly, do we find in other European countries? In Switzerland there is a compulsory day-school till 13 years of age, and compulsory attendance until 16 at an apprenticeship school for two hours on five evenings a week, or for two hours before breakfast. A candidate who fails at the examination held at 16, is liable to be detained at school until 20, and if he then fails again, he is kept at evening school, instead of being allowed recreation, during his period of service in the army. In Hungary, there is compulsory attendance at night-schools and Sunday-schools as long as lads are apprentices. In Austria and Germany, in 1873, a system of "continuation" schools (*Fortbildung Schulen*) was made compulsory everywhere. The details differ in various States, since each one manages its own education. In Saxony, for example, boys who leave the primary school, if they do not go to a higher one, must attend for three years (say till 17) at least five hours per week of continuation classes, and they are encouraged to attend twelve. Even the young waiters in the restaurants, up to 17, attend thus, and are taught one or two languages. In these countries opinion is ripening into a conviction that the education, even of the poorest class, should be continued, in some form or other, up to 16 years of age. In a very striking letter to the *Times*, dated from Berlin, on October 4, 1887, Mr. Samuel Smith, M.P., says:—

"Wherever I have gone, I have inquired how they deal with the ragged and squalid class of children, and I have been told in every city—Zurich, Stuttgart, Nuremberg, Chemnitz, Dresden, and Berlin—that such a class practically does not exist. I do not mean that there is not poverty, and plenty of it, in Germany. Wages are much lower than in England, and many have a hard struggle to live. But there does not seem to exist to any extent that mass of sunken, degraded beings who with us cast their children on the streets, or throw them on the rates, or leave them to charity. Some half-a-million of children in the United Kingdom are dependent, more or less, on the alms and rates of the community, and probably another half-million are miserably under-fed and under-clad. Nothing to correspond with this exists in Germany. The poorest people here would be ashamed to treat their children as multitudes do with us. Indeed, I have not seen, since I left home, a single case of a ragged or begging child."

And what do we in England do for the continuation of our elementary education? It is true that we have a system of night schools, and that before the passing of Mr. Forster's great Act the number of, and the attendance at, these was greater than since that date; but at no period have they been, in the true sense of the term, continuation schools. They have simply been gap-fillers, educating at night those who, by the accident of circumstances, had been passed over by day at the ordinary period. And what has been their history during the past seven years? The figures speak for themselves:—

NIGHT SCHOOLS.

Year ending August.	No. of Schools Inspected.	Number on Register.	Average Attendance.	Proportion of Night Pupils to Day Pupils.	
				On register.	In attendance.
				Per cent.	Per cent.
1880	1,363	77,307	46,069	2·00	1·62
1881	1,222	64,741	39,222	1·62	1·31
1882	1,015	53,258	33,135	1·29	1·04
1883	932	47,624	28,293	1·12	0·90
1884	847	41,567	24,434	0·96	0·77
1885	839	40,854	24,233	0·93	0·74
1886	841	42,423	26,089	0·95	0·76

Average attendance, 60·22 per cent.

What a lamentable falling off is here. The total attendance is at best but little more than *one and a-half per cent.* of the attendance at the day schools, and between 1880 and 1885 that falls to *three-quarters per cent.!* In the last report of the Committee of Council on Education, three chief inspectors out of the five who report (there are ten altogether, each of whom reports in alternate years) regret in very strong terms the "practical extinction" of evening schools. Mr. Blakiston, of the North-eastern District, regards this want as "the most glaring defect in our national arrangements for elementary education. It is beginning to be felt, and the sooner it is universally felt the better for our imperial welfare, that the large sum of money yearly voted for this purpose must no longer be wasted."

That the members of the Royal Commission are to some extent alive to the importance of the subject may be judged from the fact that their two last reports contain 522 questions devoted to evening schools, whereas the average number of questions upon each of the 138 subjects into which the Commission was directed to inquire is, in the same volumes, 334; so that the evening schools had 56 per cent. above the average number of questions. Let us hope that they obtained, if not a greater, at least an equally increased proportion of the attention of the Commission.

A very large majority of the witnesses on the subject before the Commission, whose evidence appears in the third report, were very strongly in favour of evening schools, some of them even urging that they should be carried on through the summer as well as the winter. The only points urged against them were a slight difficulty in organising them in the country districts, and, in one instance only, the risks to which girls were exposed in going to and from the schools after dark. This, I regret to say, applied to London, and the difficulty was expressly stated to be not felt in many rural districts. One inspector of a large district, who was not strongly in favour of them, eventually admitted that his opposition arose mainly out of regard for the teachers, not for the scholars, considering that those who had been teaching during the day could not well do so at night. It is obvious that the employment of the same teachers is by no means a necessity. In Birmingham, at one time, teachers who were to be on duty in the evening were excused their afternoon work.

Nearly all the witnesses, however, concurred in the opinion that the chief cause of the present failure of evening schools was their utter non-attractiveness, and that if they were to be a success, much greater latitude in their organisation must be allowed; they must, in fact, be worked under a much more elastic system than at present. It was doubted by more than one witness whether a Government inspection of such altered schools would be feasible.

Let us now consider what are the requirements and conditions of education to be given in the evening. Plainly, in the first place, it must be such as will attract, interest, and *re-create* tired children. It has to compete with the social gambollings of the street, or even with the gaudy, specious amusements which too often allure them. In the second place, it must touch and draw forth the opening nature of children of that age, so that their instinctive impulses and growing powers, both of body and mind, shall be rightly nourished and trained. Lastly, it must bear directly upon the practical work of their daily life, upon the pure enjoyments that are possible to them, and upon the noble duties that will devolve on them.

As I write, I have before me a copy of the "Evening School Revised Time-table of the Nottingham School Board for 1885-6," in which an attempt was made to solve this problem. The requirements of the Government were adhered to, but there was grafted on to the instruction thus given education of a more practical and re-creative character, which was conducted by voluntary teachers, the ordinary teachers being present to maintain order. I quote the titles of a few of these subjects:—Calisthenics; musical drill; drawing; modelling; demonstration in elementary science; geography, with special reference (*a*) to physical phenomena, (*b*) to commerce; shopping and workshop arithmetic; needlework, in making or mending garments; historical and other readings, illustrated by the lantern. Moreover, the School Board appointed seven working men to be the managers of each evening-school, and these men so laboured that during the first year of their service the attendance was doubled; one of them spent 60 hours in one month at this voluntary work. These men appealed to clergymen, employers, leaders of trade unions, Sunday-school teachers, &c., to use their influence to induce children to attend these schools, and thus there grew up in Nottingham an Association for the Promotion of Evening Schools in the town and country. It is not too

much to say that this scheme, in so far as its inception and organisation are due to the influence of any one man, owes its origin to the Rev. Dr. Paton, of the Congregational Institute, Nottingham, under whose guidance the School Board acted, and with whom the working men co-operated.

Encouraged by this success in Nottingham, the London Trades' Council, a federation of 57 large trade societies in the London district, with more than 25,000 subscribing members, and thus representing the industrial population of the metropolis, presented a memorial to the London School Board, offering the services of earnest and competent working men in various metropolitan districts, as evening school managers, and the Board practically conceded all that was requested. A provisional committee was at once formed, with the Archbishop of Canterbury as chairman, to aid the Trades' Council in enlisting and organising this personal and voluntary service, of which the School Board could take no official cognisance. From the appeal of this committee, dated September 4th, 1885, I quote the following:—

"May we further indicate what a great opportunity is now given to such as have a little leisure, and who have received some of the higher blessings of education, to go to those who seek their help, giving to them the good which they themselves enjoy, and thus to brighten and elevate the lives of the children of the working people. In this way, we believe that the various classes of our great city may be enabled to draw nearer together, especially in the period of youth, when hearts are more open and trustful; and in their mutual intercourse fulfilling each other's need, they will realise their common interests and duties in the commonwealth of the State."

Mr. T. E. Heller, the chairman of the Evening Classes Committee of the Board, also issued a strong circular asking for voluntary helpers, promising that they should be instructed, if need be, in the recreative subjects which they were to teach. Classes in several schools in London were thus started in the autumn of 1885, and on January 16th, 1886, a crowded meeting was held at the Mansion-house, in which most eminent persons of all shades of political and theological opinions, and of all grades of society, from H.R.H. the Princess Louise to the labourer, took prominent parts. At this meeting the Recreative Evening Schools Association was formed, for the purpose of promoting continuation classes in Board and voluntary schools, of which, ever since its formation, H.R.H. the Princess Louise has continued to be not merely an honorary but an active president.*

The question, "What has the Association already done, and what does it hope to do?" may perhaps best be answered by a very brief account of the methods employed, and the results already attained, the success and extension of which have been phenomenally rapid. The general lines upon which it proceeds are precisely those which proved so successful at Nottingham, and were indicated in preceding paragraphs. Out of the 128 schools belonging to the London School Board, recreative evening classes have been established this winter in 92, or practically three-fourths of the whole; 10 voluntary schools have also adopted the system. Such is the size of the metropolis that no less than 80,000 children leave its schools every year. There are, therefore, nearly half a million boys and girls in London, between the ages of 12 and 18, roaming the streets, and crowding the low places of amusement, for whom this Association seeks with the assistance of the School Board, to provide healthy amusement combined with instruction, and whom it desires to assist in fitting for the active duties of life. For the purposes of this Association, London is divided into 40 districts. In 66 of the 102 schools no less than 116 courses of systematic instruction in some branch of elementary science are being given by voluntary lecturers, some of them men of well established scientific position, and nearly all of them are illustrated by the lantern. In many of the schools manual training, in one form or another, has been largely cultivated, giving that concurrent training to eye and hand which is so generally recognised as the foundation of all technical education. In nearly every school physical exercise in some form is an essential part of the training; altogether more than 500 voluntary teachers are engaged in the London work alone.

Besides organising all this work in London, the Association is occupied in extending its special work in other towns, and at present its work is being imitated in no less than fifty towns in various parts of England, where several evening schools are being re-opened after being closed for lack of attendance. In a recent letter to the *Times*, signed by the present and the late chairmen of the London School Board, "it is estimated that, through

* Its offices are at 37, Norfolk-street, Strand; Secretary, J. Edward Flower, M.A., who will be glad to receive offers of assistance of any kind in its work.

the direct instrumentality of the Association, the attendance in the evening schools of the country was doubled in one period of twelve months."

The Association, though so recently called into existence, has already received very valuable testimony to the efficiency of its work. H.M. Inspectors report thus :—

HACKNEY.—*Rushmore-road.*—The singing and musical drill are thoroughly enjoyed by the pupils, and the tone and the discipline are excellent.

MARYLEBONE.—*Hawley-cresoent.*—The work has been made still more interesting to those attending, by the introduction of magic-lantern lectures, and a wood-carving class. A good state of discipline prevails.

FINSBURY.—*Ecclesbourne-road.*—The singing and musical drill are very pleasing, and creditable alike to teachers and pupils.

HACKNEY.—*Bonner-street.*—Musical drill satisfactory.

FINSBURY.—*Risinghill-street.*—Manual exercises with dumb-bells and wands were performed with spirit and precision, and reflected great credit on their voluntary instructors.

Two of the honorary local secretaries write thus :—

Westminster District.—A lecture on Westminster Abbey was given by the Very Rev. Dean Bradley, on Saturday afternoon, December 3rd, to seventy or eighty male and female pupils, accompanied by their teachers and managers. The Dean kindly took the company over part of the Abbey, pointing out various places of interest, and then delivered a most interesting lecture in the College Dining-hall. The Dean expressed himself delighted with the conduct of the pupils, and with the great interest they took in the lecture. He subsequently consented to become a vice-president of the local branch of the Association.

Bethnal-green Group.—The representative position I hold, being a member of the executive of the London Trades' Council, brings me daily in contact with many skilled mechanics, managers of schools all over London, and they are all of one opinion, namely, that the work of the Association is conducive of great physical, social, and moral good to the great mass of the toiling youth of this big metropolis.

A few sentences from letters of the responsible teachers, *i.e.*, the Board school officials, may be added :—

"I have been particularly pleased with the work of the R. E. S. A., in connection with these classes this session. The lantern lectures seem to be greatly appreciated. A course of lectures on physical geography has been given by a very able lecturer, who took his illustrations from the basin of the Thames."

* * * * *

"I am very pleased to testify to the usefulness and attractiveness of the aid rendered us by your Association. The lantern lectures on geography are much appreciated by the pupils, and seem to brighten the dull monotony of the ordinary routine work.

"Friday evenings, when these lectures are given, are eagerly looked forward to, and the attendance (which formerly fell off on that evening) is frequently the highest of the week. I hope you will be able to send a lecturer for physiology to start after the Christmas holidays, as the pupils are looking forward to this extra subject."

* * * * *

"It is rather amusing sometimes to notice postmen and telegraph boys who have been walking all day, running and using the dumb-bells with quite fresh vigour at the musical drill lesson. To show how some lads appreciate our evening classes, a great number were present every night, wet or fine, during last session."

* * * * *

"The fact that the average attendance is now seven times—and had not the Board divided the class, would have been nearly fourteen times—what it was the first year we started, is, I am convinced, largely attributable to the recreative work carried on under the auspices of your Association."

* * * * *

Lastly, as an illustration of the use of this work in filling up a gap in our provision for the wants of the people, I may perhaps be permitted to quote the remarks of H.R.H. the Prince of Wales, speaking at the People's Palace, December 10th, 1887 :—

"The age of entry here for boys and girls is 15. The average age at which children leave the elementary schools is probably under 12. Efforts are being made by the Recreative Evening Schools Association which I hope will meet with the success which they deserve, to utilise the school-rooms in the evening by giving to boys and girls between the ages of 11 and 15 attractive lectures, gymnastic and other entertainments, thus keeping them out of the streets, and forming a link between the Board schools and higher institutions. . . . Those who assist such work as this are rendering many a home happy by keeping boys and girls out of mischief, and richly deserve the gratitude of the fathers and mothers of Great Britain."

I am anxious to say a few words upon two branches of the recreative teaching, viz., the manual training, and the demonstrations in elementary science. The greatest importance is attached to these, since they are subjects which, for various reasons, do not succeed well, or, at any rate, are very little carried out in the ordinary day-schools, and yet it is generally acknowledged that they are the only sure foundation for that technical education, the

need of which, in this room, needs no more than a passing allusion. And first, as to manual training, including under that general term the use of tools, wood-carving, fret-work, modelling in clay, drawing, and any pursuit which involves the concurrent training of eye and hand. Very great care has to be exercised that what is taught is not in the least open to the charge of being called a "trade," since if it were so, the sympathies of the working men would be at once alienated, and the jealousies of the trades' unions would be aroused. The same difficulty is now being felt in the United States, where an Industrial Education Association has lately been formed in New York city, from one or two of whose recent publications I take the following sentences. "No subject is receiving greater or more serious consideration in the educational world at the present time than that of manual training. There are more than ten millions of children in the public schools of the United States, of whom certainly two and a-half millions must support themselves by the labour of their hands. The State is spending many millions of dollars every year to develop the brain power of these children, and the State does well; but it would do better if it should do also something to develop the immense amount of hand-power which is almost wholly neglected. Trade schools are confined to particular branches, manual training is comprehensive. Its prime object is the education of the mind, and of the hand as the agent of the mind, ... to lay the foundation for mechanical pursuits, just as our present literary system lays the foundation for professional and literary pursuits. . . . . Instruction in the use of common working tools does not necessarily teach our boys to become mechanics any more than instruction in Latin and Greek teaches them to become lawyers or physicians. To use a much-quoted expression, it is 'putting the whole boy at school,' and educating him on all sides, giving him a better mental and physical preparation for life's work. The object is not to train apprentices and teach trades, but to drill pupils in the fundamental mechanical principles which are at the basis of all trades, and, above all, to foster a higher appreciation of the value and dignity of intelligent labour, and the worth and respectability of labouring men."*

These sentences well express our aims, and it gives me pleasure to draw your attention to these specimens of such work which are here exhibited; among them a piece of fretwork, kindly lent by our distinguished president, H.R.H. the Princess Louise, for whom it was executed by a lad who had only received five months' training, with one lesson a week. Commendations of this portion of our work are constantly being received, and I may here refer to Sir Charles Warren's opinion in favour of schooling in which boys are taught some kind of handicraft rather than mere book learning. Moreover, as Mr. Goschen pointed out very recently at Aberdeen, in words which should be written in letters of gold, our young people have not, as a rule, been taught to care for their work, of whatever kind it be, in the same sense as a German workman, for example, cares for his. Nor will they do so until the schoolmaster insists on genuine hard work, while at work, with just as much energy as the boys themselves insist upon hard work while at play.

A few words now upon the lantern demonstrations. I think that we are only now beginning to realise the power and use of the lantern (let us by common consent drop the prefix "magic," so suggestive of frivolous amusement) as an educational agent. Eyes wearied with long use during the day cannot endure the fatigue of much bookwork at night, but they are revived and charmed by the splendour of gay colour and brilliance of light. Are not we adults even conscious of this in our own persons? My own experience as a lecturer tells me that, under ordinary circumstances, lantern illuminations add greatly to the interest of the lecture, and increase both the number and attention of the audience. Now that the preparation of photographic lantern slides is such a comparatively simple matter that a large number of science teachers prepare their own, as I have been in the habit of doing for some years, there is hardly any subject capable of pictorial illustration at all—such as history, biography, travel, and a number of even purely literary subjects, the teaching of which may not be brightened and illuminated, in more senses than one, by the use of the lantern. But it is when we come to the demonstration of elementary science that the enormous advantage is felt. The evidence given by many witnesses before the Royal Commission, the yearly reports of the British Association on instruction in science in elementary schools, and the reports of H.M. Chief Inspectors, all tend to show the deplorable condition of science in elementary schools.

* See also "A Plea of for the Training of the Hand," by D. C. Gilman, LL.D., President of the Johns Hopkins University, Baltimore.

The teaching of it is positively decreasing, and, except in a few of our large towns, is practically non-existent. Here and there a bright spot occurs in the inspectors' reports, as, for example, the town of Nottingham, where science subjects are taught on what is now known as the peripatetic system, which I had the honour of describing to the Society in this room a few years ago. But, in the last report of the Committee of Council on Education, the five chief inspectors practically concur in the statement that nothing could be more unsatisfactory than the present position of the knowledge and teaching of science in our elementary schools ; moreover, when they investigated the subject in the training colleges, they found the average pupil teacher notably deficient in many branches, especially in the elements of that fundamental subject, mathematics. Their examinations give evidence of mechanical and unintelligent teaching; the answers being too frequently given by rote without thought, while questions involving a little thought are left unanswered, and the students appear to regard the obtaining certificates as the end and aim of their existence.

An eminent London professor of chemistry, in looking back on Monday night over twenty years' of teaching, and many of whose pupils are drawn from the lower middle class of society, animadverted strongly upon the present system of education, at any rate in so far as it was preparatory for a scientific training. He remarked of those who came to him as pupils that, "they will not think, they cannot think, and they resent being called upon to think."

If this be the state of things in the day schools, is it not incumbent upon us to encourage and develop by every means in our power the teaching of science in evening schools, not only as a preparation for technical education, but still more for its own sake as an educational instrument, and to put the young people into an intelligent relation with the phenomena of the world in which they live? The figures I have quoted show how large a place science occupies in the programme of the Recreative Evening Schools' Association, and with your permission I will demonstrate to you a few simple facts, to show you the capabilities of the lantern as a piece of educational apparatus, apart from the projection of ordinary slides. You will observe that the construction of the lantern I have here is somewhat novel, and that it has a number of pieces of accessory apparatus. It is one which I have designed, after some years' constant experiments, for school use, and of which ten were constructed a few months ago, at the cost of the trustees of the Gilchrist Educational Trust—a prominent member of which body has honoured us by taking the chair to-night—and by them have been most liberally handed over, as a sort of permanent loan, to the Recreative Evening Schools' Association.* Its essential feature consists in the insertion between the condenser and the projecting lens of an adjustable table, upon which experiments can be performed with small apparatus. A prism is added for erecting the image to be used in front of the projecting lens, and also an apparatus for projecting on to a vertical screen experiments necessarily performed upon a horizontal surface. One novel application of this last is the use of a piece of smoked glass, upon which diagrams can be drawn, and words written, by a needle point, thus practically converting the white screen, *pro tem.*, into a blackboard, on which an invisible hand writes in luminous chalk!

[Several elementary experiments were here projected on the screen, illustrating different branches of physics and chemistry. The rotation of a radiometer, the electrolysis of water, and the formation of magnetic fields, were especially noticeable. A large series of coloured slides, illustrative of human physiology, were exhibited, and it was stated that one of the honorary secretaries of evening schools, himself a demonstrator in a London hospital, had expressed great regret that such excellent aids as these were not available in his daily work.]

Finally, may I venture to point out what, in the opinion of those who have studied the subject, are the alterations which they would desire to see in the existing law, as regards elementary schools, both day and evening. These will, in all probability, be embodied in a Bill, soon to be brought into the House of Commons, and I would most respectfully and earnestly commend them to the consideration of every member of Parliament who may be present, or who may read these lines, as well as everyone who can influence such members. They are:—

1. The standard of age for total exemption to be 13.

2. The standard of qualification to be, for the present, the sixth.

* The maker is Mr. W. C. Hughes, 82, Mortimer-road, Kingsland, N.

3. That there be two evening school schedules; (*a*) for those under Standard VI., (*b*) for those above Standard VI.; and that in this last, three "specific" subjects take the place of the "three R's" as compulsory subjects.

4. That in both schedules, musical drill, or calisthenics, singing, art hand-work for boys and girls, and cottage needlework for girls, be extras, for which half the present grant be allowed, viz., 1s. 6d. Also that cookery be allowed as an extra, and that 6d. or 1s. be allowed to schools, for the use of lanterns, objects, experiments, and applied teaching generally.

It will be observed that none of these changes are very radical, that they are all in the direction of more elasticity in the programme, and that abundant evidence is forthcoming as to the efficacy of the plans proposed. Moreover, they have the additional advantage of not increasing the amount of the Government grant (except, of course, by an increase in the scholars), since a better distribution of the amount at present granted is all that is asked for. The issues at stake are, however, so tremendous, that in this case I think that the most instructive consideration for us is the *cost of doing nothing*. We are grappling with the root-cause of the social question. No money, in however large amounts, can prevent the recurrence of distress arising from unthrift, vice, self-indulgence, and reckless and improvident marriage. In order to deal with these factors in the problem of our great city, we must capture the boys and girls who will be the fathers and mothers of five or ten years hence. If, when captured, their lives and habits are moulded at the impressionable age, from 14 to 21, so as to become good citizens, and not reckless pleasure hunters, unaccustomed to resist the impulse of passion or the suggestions of desire, we are, in point of fact, sterilising the unfitness latent in them, and thus preventing the formation of a new national debt of vice and crime. The birth-rate in Hampstead is 23 per 1,000, that in Whitechapel is 36. What thoughts are suggested by this simple statement of fact! The population of the British Islands is, in round numbers, 36,000,000, and, according to Lord Halsbury, it is increasing at the rate of 300,000 per year. If the figures I have just quoted be taken as typical (and I believe that they may) it is clear that the very class whose increase we can most easily dispense with grows at the most rapid rate. Under the heading, "Lazarus and Dives," a correspondent of the *Standard* remarked a day or two ago:—"Every poor man seems to think that the command to 'increase and multiply' is one that is absolutely incumbent on him to fulfil. The obligation to feed, clothe, and provide for those whom he has thus brought into the world must devolve upon his richer neighbours. What is to be the final result?"

As the Chairman of our Council told us in his opening address on November 16th, for more than thirty years the Society of Arts has made the subject of education a part of its standing work, and that it has long been contended within these walls that the elementary education as now given fails to create a supply of boys fitted to take up at once the practical business of life. It has been my privilege to-night—and a very great one I feel it to be—to bring this most important subject again before the Society. To my own mind, the facts given in the first portion of this paper are so appalling, that any one who is really alive to their true import ought to have no rest until such a state of things is altered. I trust that this great cause will not suffer from the imperfections of its present advocate, and, as it may perhaps be thought that some of my preceding quotations present the subject in somewhat too highly coloured a form, I will conclude in the well-weighed words of an official, Mr. J. B. Blakiston, Chief Inspector of the North-Eastern division of England, who writing with a full sense of the responsibility of his position, thus closes his last report to the Committee of Council on Education:—

"Already by means of higher and sounder attainments, thriftier habits, and more thorough training, foreign competitors are pushing from their stools, in the drawing-office, the engine-room, and the counting-house, the more imperfectly informed and the more self-indulgent of our countrymen. If we are to maintain the high position won by our fathers' enterprise, energy, and perseverance, our masses must receive such thorough and enlightened training as will fit them to hold their own against the world. Otherwise our place among the nations will be taken by rivals less gifted by natural resources, but more alive to the advantage of education and self-control."

DISCUSSION.

The CHAIRMAN said they must all be grateful to Mr. Carpenter for giving them the benefit of his experience on the subject of education in connection with continuation schools. The country seemed to be somewhat startled that evening schools were

failing, and that the attendance and educational results were less than formerly, but they ought not to be surprised. In 1870, when the Education Act was being discussed in the House, he rather startled Mr. Forster by telling him that it was no use introducing evening schools of the kind he intended to form by that Act, because, as he said, the moment day schools were provided giving elementary education, the evening schools ought to fail unless their character were entirely altered. Evening schools were of importance, when there was no compulsory education throughout the country, to give education to the poor neglected working man, but directly you began to get a more educated class, owing to compulsory education, evening schools ought to fail. Enormous advantage might be derived from evening schools if they were continuation schools, made practically useful for the work which working men had to perform in life--not to teach the work but the principles on which the work depended, so as to enable them to have that trained intelligence which was absolutely necessary in the competition of the world. Whether it was called technical education, continuation schools, advanced schools, or any other term, what was wanted was a trained intelligence amongst the working men to enable them to apply the trained intelligence to the varying work which they had to perform, and this education was provided in all countries but England. Mr. Carpenter had strongly pressed on the Gilchrist trustees the importance of educating by means of an illustrative lantern, and they had seen that evening, by means of the different illustrations, how a great deal of science, without expensive apparatus to the student, might be imparted, and the principles underlying the ordinary natural operations which were around them, and even the operations of industry could be illustrated in this way. They had seen that evening how largely the lantern might be made use of for educational purposes. Children under the compulsory law now left school at about twelve years of age if they had passed the requisite standards, and were supposed to be equipped with the educational armour which was necessary for after-life; but instead of having any armour at all, they had the thinnest possible veneer of education. In some cases they could leave school after they had passed the 4th Standard, but in some towns they were able to leave school after they had passed the 3rd Standard, and in those cases the education which they had received was such as could hardly be called by the name of education. If our own children at the age of twelve or thirteen had their education stopped at that early age, how could we expect them to win the battle of life. That was what was being done at the present time for the working man; more than five-sixths of the working men had to win their bread by manual labour of some sort, and their children had to engage in the battle of life without the education necessary for them to prosper. They were utterly unequipped for the industrial battle throughout the world, and they had against them the educated competition of other nations. No doubt Englishmen were surprised at the long-continued period of depression, and the question naturally arose why this depression continued so long. Formerly it used to come once every ten years, but during the interval there was a period of prosperity. The present depression began in the year 1873; there was a little mounting upwards in 1879, 1880, and 1881; but from 1873 until the present time there had been a continual decline of prices, and yet they were asked why the depression had changed its character so much, and the depression had been so long continuous. Trade began to improve at the end of last year a little, but during the present month there had been hardly any improvement, and the reason for this was that the world could not adapt itself sufficiently rapidly to the changes which science had made in production. The change had been enormous. Other countries had known that industry had ceased to be a competition between nations of local advantage and raw materials; that it had been converted into a competition of intellect, and all great nations, seeing the competition of the future must be a competition of intellect in the working man, had been spending enormous sums on the working man to take part in the battle of life, whilst England had hitherto been satisfied with mere primary schools. In 1852, he proposed a resolution in that room to the effect that the working man of England must be put in a position to receive technical education, in order to compete with the growing intellectual competition of the world. This resolution was seconded by Lord John Russell, but yet in the year 1888 they were only just beginning to talk of it in the House of Commons. France had done a great deal in this direction. The French Institute had discussed the question of why it was that the great crisis of France produced no intellectual leading men, and they decided it was owing to the fact that they had neglected the education of the country. France and Germany were now fighting to see which could most rapidly develop the intellectual position of the country, and France was spending enormous sums in this direction. Germany was also doing the same thing, and that country had lately been building a technical school for the artisans at Berlin, at an expense of over £400,000. When she took Strasburg from the French she began to erect fortifications against France, but she had lately erected an intellectual fortification in the shape of the university upon which she spent £700,000, and expended about £30,000 a-year upon its maintenance. Last year in England a little Bill was brought forward for technical education to allow the children of the working man, after they had passed the 5th Standard, to do a little with their hands and eyes, but there was an organised opposition to it. It was said they were at-

tempting to teach high education to the boys who would only afterwards have to do manual work, and consequently the Bill was defeated. That Bill would again come forward this year, when, no doubt, it would receive some better attention. Unless they trained the intellect of the working men of England, they must be prepared to lose their industrial position as a nation. The present was a scientific age. It had been altered by the scientific inventions made since 1873 in a most extraordinary way, for it had altered commerce as well as industry. The means of production had been made greater than the demand, the effect of which was, that Englishmen had no local market with which to sell their goods. Owing to the economy with which goods were distributed all over the world, the world had become one large market. For instance, take a little cube of coal which would pass through a ring the size of a shilling; owing to the new improvements in modern steamers, a ton of cargo could now be transported with it for a distance of two miles, and an experiment was lately made at one of the London and North-Western Railway Company's stations, when it was found that with two ounces of coal, a ton of goods could be driven for a distance of one mile by a compound locomotive. Owing to the economy in coal, and the cheapness of distribution, the world had become a market for all commodities, and if any other country could produce commodities cheaper than England the whole world would become a market for those commodities. They must train men to be citizens and traders not of England alone but citizens and traders of the world. England could not remain in its insular position. It must be prepared to take its part as one of the producing centres of the world. He was glad to see that the thin end of the wedge was now being introduced by the Recreative Evening School Association, and as a supplement to this technical education must not be neglected any longer. Our present system of elementary education is wasteful, because it is unproductive. We spend much treasure on education, but it bears little interest. By continuation schools the present system of education will be made more productive. The unsatisfactory condition of education must be attacked over and over again until the English people were aroused to the fact that it was a question which must be at once grappled with; for pride would not allow them to remain in the rear of industrial competition, and consequently they must give artisans that trained intelligence which other civilised nations were giving in order to fit our workmen to compete successfully with other nations.

Mr. H. H. Cunynghame thought this subject could only progress by being continually hammered at in the way suggested by the Chairman, and he hoped the hammering would be continued. In his opinion it was necessary to catch the children very young, and £10 spent on a lad before he attained 21 would do more good than £100 spent afterwards. It was found that if a lad could be kept from crime up till 25 he would rarely afterwards commit crime. A great deal had been done in this matter by the City Guilds, and he trusted some action would be taken by the Charity Commissioners. As far as could be seen, they intended to do something for children of the age of 15 or 16, by contributing to schools in which science education should be provided, but the gap between the time when children at present left school, and the age of 16 must be filled by the Recreative Evening Schools Association and the School Board. Another society which had been doing very good work in this direction was the London Society for University Teaching, which gave popular lectures of the description referred to by Mr. Carpenter, such as young men could understand. These lectures, he was pleased to say, had been attended by over 20,000 pupils. In the Continuation and Board schools a little more might be done in the direction of education, because at the present time the education given in Board schools in the higher subjects was in a deplorable condition. Physiology seemed to be taught at all schools, giving one the idea that the pupils were all going to be doctors, but dissections were prohibited, as was also the use of a skeleton. Book cramming was the curse of education. Physiology was studied to the neglect of geometry and other subjects which it was necessary for artisans to have a knowledge of. It was really time for English people to wake up upon this subject, as they were in danger of being beaten by foreigners. England had the finest mechanics in the world, but their intellects were being starved by a penny wise and pound foolish policy.

Mr. J. E. Flower said it fell to his duty, or rather, he made it his duty, to go about London pretty extensively, to drawing-room and public meetings, and to visit neighbouring places, to expound the aims and methods of the Recreative Evening Schools Association, and wherever he went he found his information came as a perfect revelation to nine-tenths of the audience. Mr. Carpenter had indicated that it was one of the objects of the Association to set going local associations all over the country, and this, he was glad to say, was being done to a very large extent. He had, during the last few days, conducted a meeting at his own native place, Beccles, and was glad to say that the idea had been cordially adopted. He found there was a readiness on the part of the cultured classes to give voluntary service, and an eager desire on the part of the working classes to receive the education so given. Personally he felt most grateful to the Gilchrist trustees for providing the ten lanterns, and trusted that before the coming winter they would see their way to providing a further supply, as there was plenty of opportunity for putting them to excellent use. It might not be out of place to say that the Association were prepared to lend lantern slides to local associations at

a merely nominal charge, and that contributions in kind would be most thankfully received at the head-offices.

Mr. A. P. WIRE, as a Board schoolmaster, said he had adopted the plan of teaching drawing in all the standards, but he could not find teachers for solid geometry. In his own school the subject was suffering from the action of the Science and Art Department, which had only made a general report that the drawings sent in by the school were "good," and had not awarded a single certificate or prize. As a teacher, he should like to teach so as to give the pupils a liking for knowledge, but the action of the inspectors was very much against them. He had encouraged his boys to do a large amount of art work, but the inspectors told him that he taught too much drawing, and upon one occasion he had been severely taken to task for not having a higher per-centage of efficiency. He felt that he had done what was right, and should continue so to act. Education by means of lantern exhibitions was very successful, as he had proved from his own experience. He believed that much good might be done in this manner, and hoped that it would be largely encouraged.

Mr. B. LUCRAFT said that they were not allowed to teach what he thought they ought to teach in evening schools, but he hoped the time would come when they would be able to do so. Evening schools would be more attractive if they could follow up the education given in day schools; but, unfortunately, the London School Board did not take sufficient interest in the matter. A higher technical education for the working classes would benefit the nation, and, in his opinion, the education ought to be given free. He hoped it would not be long before those in authority saw that it was for the benefit of the nation to encourage, instead of repressing, technical education. He wanted to see institutions where a mechanic might go to hear lectures, and learn how best to do certain things that he was not able to find out in the workshop. The School Board had brought out a report showing where such institutions might be set up, and where the means were to come from, but up to the present nothing had been done. In his opinion, children ought not to leave school before they arrived at the age of 13, and he was in hopes that before long something would be done to prevent their leaving at too early an age. He had attended meetings 20 years ago upon the subject of technical education, but up to the present time nothing worthy of the name had been done. He maintained that drawing should be made compulsory for boys and girls. Many people thought it was unnecessary for girls, but such was not his opinion, as he considered it often gave them a good start in life.

The CHAIRMAN, in proposing a vote of thanks to Mr. Carpenter, said allusion had been made to the necessity of legislation upon the subject of age at which children should leave school, but it would be tyranny to increase the age at which children should leave school, unless an education suitable to the increased age were given. Parliament could not be expected to increase the age unless it were shown that schools were provided, or Parliament was willing to provide them, in which education suitable to the increased age was given.

Mr. CARPENTER, in reply, said many remarks had been made about the techincal education of the working man, but he had purposely said very little about this aspect of the question, as it was one upon which all were agreed. He had dealt more with the social aspect of the question. The movement to which he had referred had arisen from the action of working men in Nottingham, and its adoption in London had arisen from the action of the working men themselves through the initiative of the Trades' Council, so that it had all the elements of a thoroughly solid foundation.

The vote of thanks having been unanimously accorded, the meeting adjourned.

FOREIGN & COLONIAL SECTION.

Tuesday, February 7, 1888; Sir FRANCIS DILLON BELL, K.C.M.G., C.B., Member of Council, in the chair.

The paper read was "British Columbia," by HENRY COPPINGER BEETON, Agent-General for British Columbia.

The report of the meeting will be printed in next week's number of the *Journal*.

Miscellaneous.

THE THAMES CONSERVANCY BOARD.

The *Journal* for Aug. 18, 1882 (No. 1,552) contained an account of the organisation of the Thames Conservancy Board, the increase of its powers from time to time, and references to the clauses of the Acts which defined its power with regard to the prevention of pollution. In 1857 it was constituted, but not till 1866 had it any control over sewage pollution. It has many duties with regard to navigation, landing stages, fisheries, &c., and on the whole of its yearly work it has to make a report to Parliament. In the notice in the *Journal* some

quotations from the 1881 report were given in regard to pollution, that being the first year in which it was stated that "the river above the intakes of the water companies is now practically free from sewage contamination." The reports issued since then bring the account of the work of the Board down to the end of 1886. The preparation of the accounts, the presentation, the order for printing [in this case, July 5, 1887], and then the printing and issuing, caused the appearance of a report to be delayed long after the close of the year to which it refers. Each year the state of the river above the intakes of the companies has received a special paragraph. In 1884, it was reported as "satisfactory." In 1885, it was stated that some sewage from Staines still found its way into the river. Owing to the low lying position of Staines "great difficulty has been experienced in disposing of the sewage. The Conservators have obtained several convictions against the local authorities for allowing sewage to flow into the river." The 1886 report again refers to the difficulty of Staines. Several summary convictions have been obtained against the local authority of the town. These proceedings, however, did not lead to the diversion of the sewage of the town from the river. The Conservators state that they are "instituting proceedings by indictment against the authority with a view to compelling them to execute the necessary works for the purpose."

There are also a "very few minor instances" in which action is being taken. But with these exceptions, the sewage from all towns and places above the intakes of the water companies has been diverted from the Thames. Constant supervision is exercised by the officers of the Conservators, and when the list of towns that have had to be dealt with is referred to,* it will be recognised how great a work the Conservators have had in enforcing the law.

In addition to sewage, constant watchfulness is needed against throwing rubbish in the river. In 1884, there were fourteen cases in which persons were prosecuted and fined for infringing in this respect. In 1885, there were forty-one convictions, and in 1886, forty. The convictions were largely due to the assistance of the Thames police, and the offences were for throwing "rubbish, mud, ashes, and other offensive materials."

But while these considerable precautions are taken to secure the purity of the water above the sources of the water supply, that is to say, above Hampton and Teddington, a very different state of things exists below. From Chiswick downwards, as far as Barking, the control of the sewage is vested in the Metropolitan Board of Works. But between Hampton and Chiswick, however, there is no control, as the penalties for polluting are suspended by Act of Parliament, or were till the July of this year. Two places, Twickenham and Chiswick, are reported to have dealt with their sewage, whilst others are preparing for the execution of works to divert it from the river. [The "are preparing" occurs in the 1885 report, while no reference is made to the subject in the last, the 1886 report.] As regards the portion of the river below Chiswick, the Conservators have never had any pollution or sewage control, that being under the Board of Works.

* *Journal*, 1,552, p. 929.

The 1886 report concludes with these assuring words, "In the far more important districts above their sources, with a few minor exceptions, the sewage of the towns has been efficiently dealt with, and the river water kept in a satisfactory condition for the supply of the metropolis."

In addition to preventing pollution by enforcing the power of inflicting money penalties on "authorities," the Conservators, in the older capacity of guardians of the Thames navigation, have effected much useful work which has sanitary bearings. There are extensive mud banks in places which, in times of small river flow, have been exposed.

Two steam dredgers have been kept at work to improve the foreshore, and in some districts stone facings have been put to the banks. In the last report issued, it was stated that it was expected that all the works then in contemplation would be completed by the end of 1887. What further improvements may still be taken in hand are not indicated.

Correspondence.

THE IMPERIAL INSTITUTE.

The utter impossibility of encountering the cost of an adequate site in some central part of London, has been the cause of our great commemorative Institute being reared in the comparatively remote area of South Kensington. But this remoteness of situation gave rise to the idea of a City branch of the Institute, devoted more especially to a permanent exhibition of commercial products. Still there was the old difficulty as to site-cost, for although the required area for the branch was much diminished, the expected subscriptions for this partial object could not be great. Indeed, they amount as yet but to £5,000, while a site could hardly cost less than £50,000 to £100,000. This branch of the Institute idea, therefore, may be said to hang fire under the unsolved problem of the site-cost.

The subject was warmly taken up last year by our London Chamber of Commerce, of whose Council I have the honour to be a member; and I there took my opportunity to suggest a resource which would surmount the site-value difficulty, but which was of so entirely novel a character as to fail, at least on this first effort, to move the London mind out of its accustomed groove. What I proposed was that, seeing the the surface was unattainable, we should betake ourselves to the subterranean

where we might have area free for the asking, at only the cost of burrowing, and where the science of our day would supply every need in lighting and ventilation, and in all architectural appliance, including the safe underpropping of adjacent superstructures, as to which the late experiences of the District Railway Company seem entirely satisfactory. I had the exact spot in view also, beneath which we were to excavate our Institute, no other than the very core of London business life, the open area in front of the Royal Exchange.

As I propose to follow up my suggestions by offering, through the Chamber, a prize, say of £50, for the best and most practical essay upon such an Institute so constructed, your readers might be interested to learn what could be said upon so novel a subject. I will therefore sketch out my own idea, limited as it must be to the generalities of a non-professional.

The chief feature I make to be a spacious and lofty sub-area, surmounted by a great dome, whose apex is to emerge, under glass cover, upon the said open area, receiving therefrom probably all the light necessary, while the present open aspect is still but little altered. Further accommodations may be ranged around and outside of this great central area or hall, and artificially lighted; or, if the latter be large enough, these wings could be dispensed with. We may add to our resources for institute purposes by surrounding our great hall with a series of connected inside galleries.

Next, as to the access. That I propose in two forms. First, by a continuously-going lift, involving not only no fatigue but perhaps less time than an ordinary one-floor staircase. Second, by an easy gradation of descent, winding around and outside of the great central area. This latter access might be a well-appointed street, lined with shops, to do a busy trafficking, and to yield a good rental. Some part of the hall, also, might yield rent, and I have some hope that, by capitalising all this rent-roll, we might construct our Institute almost, if not altogether, free of cost.

A concluding consideration is as to the disposal of the vast excavation material. Well, we are to remember that our great Thames Embankment scheme is still far from complete, and that we have, in all this handy material, so effective an aid for its further prosecution, that we might even look for a concurrent resumption of work in that direction.

WM. WESTGARTH.

THEATRE CONSTRUCTION.

Being familiar with most of the theatres of Europe, and particularly with those in the capitals of Russia, Austria, Germany, Italy, France, and Belgium, I venture a few remarks after a careful perusal of what has been said upon the subject in the *Journal*.

As regards site, I must say that I think that the position of the playhouse has hardly had the attention that it deserves, and that the main point of surety has been somewhat discounted. Interior arrangements, the choice of materials used in construction and decoration, with the lighting and watering, holding the first place, when in fact the exterior, as an element of safety, is of paramount importance.

It is unfortunately a fact that most of our places of entertainment are situate in populous quarters, on which they may be said to have grown, and upon sites totally unsuited for such edifices.

That a theatre, hall, chapel, or other edifice should be hidden away amongst houses is certainly economic, with its one principal entrance in a grand thoroughfare, though here is a great source of danger.

All halls of assembly and theatres where audiences are packed should be isolated, and moreover have both internal and external corridors or galleries, and where there is a stage, that the edifice should be cut in twain by an iron gate, shutter, or curtain; the materials used in the construction of the house would then be of secondary importance.

In Germany and France there are many most admirably designed theatres that stand perfectly alone, looking externally what they are—playhouses—with all their parts being visible.

In building a theatre, or in constructing a theatre, *de novo* the first fact for the consideration of the authorities should be, not alone the edifice, but its surroundings and the safety of the whole *éncènte*, there being no reason why the site should be diminished in value or in security, when, in fact, it might be enhanced in both, by the erection of shops for trade only, on either side of the grand entrance of the principal front, under the *foyer*, with a balcony in front, and whilst all along the two sides there might be made the same proviso for the immediate exit of the whole audience to the plateau over the shops, a halting place in case of emergency. The extreme back might be a perpendicular wall, with or without an area beyond, or with offices or appurtenances for the stage.

To render your edifice incombustible is, of course, of high importance, but the safety of the audience is of much more need; indeed, Parliament has a duty to perform to the commonwealth to preserve it against destruction—from being asphyxiated, cremated, or paralysed by panic in contracted quarters, without the means of succour at hand.

The safety of the public is the matter of the most importance, and in this they ought to have all the aid legislative enactment can give them, leaving minor details to lessees and landlords.

JOHN LEIGHTON, F.S.A.

Royal Institution of Great Britain,
Feb. 4th, 1888.

SANITATION IN INDIA.

I regret that I was unable to attend the reading of Mr. Justice Cunningham's important paper. If I had I should have taken exception to Sir George

Campbell's assumption of complete knowledge of the powers of sanitation. Sir George Campbell is reported to have said in the discussion that "he did not think that sanitary science had as yet reached anything like perfection, though he admitted that great steps had been taken." He also stated that the authorities in India "had been most anxious to grapple with it, and if they had not succeeded so completely as they could wish, it was because the problem was much more difficult than Mr. Cunningham seemed to suppose." But who is it that imagines that sanitary science has reached perfection, any more than mechanical science—which, in its application to railways, is now revolutionising India—has reached perfection? Sir George cannot be aware that sanitary science at an English orphanage at Calcutta had reduced the death-rate there to one half the death-rates prevalent amongst the children of the same age in England; nor can he be aware of various other evidences of the power of obtaining English succession in India, which were brought forward in a discussion on a paper by General McMurdo, in March, 1878, at which I presided. He cannot have observed upon the inquiry which I obtained from Lord Ripon into an example of the application of sanitary power in Algeria, in an instance where the death-rate had amounted to as much as 100 in a 1,000, and three sets of troops were decimated; but where, by drainage, by water-supply, by improved culture, the death-rate was reduced to 12 in 1,000, or three lower than the mortality of the French troops occupying Rome. Sir George cannot be aware that Mr. Robert Ellis, the Sanitary Commissioner of Madras, and other Indian authorities, declared that that example was applicable to the greater part of India. He cannot be aware of the example set by Mr. Ellis, of dealing with pilgrimages, which were reported to have brought pestilence with them, till he prevented it by the application of sanitary science, in cleansing and reducing over-crowding. Sir George is further reported to have said that "from his own personal observation, he entirely disputed the notion that cholera was a preventible disease, and that it could be abolished." Now, he could not be aware of the fact that by the sanitary regulations in England, provided by the first Board of Health, a reduction of full 50,000 deaths was effected beyond that of any country in Europe. I was at pains to take Sir George to see the district school at Anerley, where the children's diseases, whooping cough, scarlatina, measles, typhus, are entirely abolished by sanitation, and the death-rate reduced to less than 3 in a 1,000, or less than a third of the death-rate among children of the same ages among the general population. I fear that Sir George has yet to profit from what he saw on that occasion. He talks of the anxiety of the Indian authorities to grapple with this matter, but they have had for a long time before them a practical plan for the sanitation of Poonah, and the application of the sewerage to agricultural production, by Colonel Ducat, though the Government have failed hitherto to give the requisite attention and pressure to them. In the Reports of the first General Board of Health for 1852, we proved, as a fact, that irrigation by submersion created marsh surfaces, and generated ague, and other diseases. From want of sanitary knowledge for its guidance, the Indian Government works of irrigation have been, and, I believe, are now, continuously carried on in a manner to create marsh surfaces, and to generate malaria wherever they are carried. One Indian Minister expressed to me his apprehension of the effect of sanitation in removing the Malthusian check to the increase of population.

In my Report of 1842, on the sanitary condition of the labouring population, will be found reference to the evidence that ordinary pestilences do not diminish population, but only weaken it; that after a visitation of a preventible disease, an increase of conception occurs that replaces the children lost. At the time that Malthus wrote, the population of England was only ten millions. I may conveniently quote the example of Lancashire, where the population, at that time, was half a million, but at the last census was three and half millions, and will probably soon be as much as the population of all Ireland. When Malthus wrote the death-rate in the chief towns was 40 in the 1,000; it is now (though still from imperfect knowledge of sanitary science too high), some 27 in a 1,000. But notwithstanding the continued increase of labour-saving machinery, there has been from the increase of wages a continued decrease of the pressure of population on the means of subsistence, so that the population is altogether safer as well as better. A similar result I am confident will be found to be attendant on the better understanding and proper application of sanitary science for the relief of the population of India.

EDWIN CHADWICK.

East Sheen, S.W.,
Feb. 8, 1888.

Notes on Books.

COLOUR: An Elementary Manual for Students. By A. H. Church. New Edition. Cassell and Co. London, 1887.

This is a considerably enlarged edition of a manual published by the author in 1871, on the same subject. Its object is to give artists an idea of the scientific principles on which their work rests. Commencing with a short account of the theory of light and the chief phenomena connected with it, Professor Church passes on to a description of the actual nature of colour, and of the way in which it is produced. The phenomena of reflection, refraction, absorption, polarisation, interference, &c., are briefly explained, and this results in the production of colour described. The theory of the true primary

colour sensations is described, and the reason given for the use of the term. A classification of colours is given, and the effects of contrast explained and accounted for. In the latter portion of the book the author gives the practical applications to artistic purposes of the principles and theories explained in the earlier chapters. The last two chapters of the book deal for the most part with the modifications in colour arising from surface and structure, and with the colours proper to certain substances, glass, porcelain, gems, &c.

Obituary.

Sir Henry Maine, K.C.S.I.—Sir Henry James Sumner Maine died suddenly of apoplexy at Cannes, on Friday evening, 4th inst., at the age of 66. Full obituaries of this distinguished man have been given in the newspapers, and a specially full one will be found in the *Times* of Monday, 6th inst. It is only necessary here to mention his association with the Society of Arts. To him was made the first award, in January, 1864, of the Swiney Prize for the best published work on jurisprudence. The prize was awarded for his "Ancient Law," published in 1861.

General Notes.

Telephony at the Brussels Exhibition, 1888.—The Administrative Council of the Concours International has determined to give great prominence to practical applications of telephony, with a view to popularise recent improvements. To this end a complete telephone exchange will be established in the grounds, with stations in the principal annexes, by which exhibitors may communicate with one another, and with visitors in the restaurants, cafés, &c. By a projected arrangement with the Bell Telephone Company communication will also be made, through the central station, with the Exchange in Brussels and the other large towns of Belgium, and, indeed, neighbouring countries.

Hygiene and Life-saving Exhibition at Ostend.—An International Exhibition of Hygiene and Sauvetage has been organised for Ostend during the present year, to be held in the Parc Léopold, under the auspices of the Communal Administration. It will embrace all that relates to public, private, industrial, naval and maritime hygiene, and will include a special section connected with childhood, with another devoted to the saving of human life under various circumstances. During the Exhibition, which will remain open from the 1st June to the 1st October, an international gymnastic competition, races, regattas, &c., will be held. Further particulars and conditions may be obtained of the Organising Committee, 3 Rue des Regnesses, Ghent.

Apprenticeship in Belgium.—The Syndicat d'Ameublement, or Furniture Syndicate, of Liége—the Birmingham of Belgium—has just organised an *Atelier d'Apprentissage*, or apprenticeship workshop, the regulations of which have been published in the Bulletin of the Liége Chamber of Commerce. Candidates must have completed their 12th year, and possess a certificate of having received elementary instruction; they must also attend a night school during the term of technical instruction. They must serve three years without wages, and at the end of that period will, on passing an examination, receive a diploma of competency. Prizes will be placed at the disposal of the Communal Administration, to be awarded both to successful apprentices and to the masters who have superintended the technical instruction afforded; and the masters who form part of the Syndicate undertake to give preference to certificated apprentices.

Correction.—Page 257, column 2, foot-note, line 1, for "cholera" read "disease."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 15.—"Type-writers and Type-writing." By John Harrison. Sir Henry Thompson, F.R.C.S., will preside.

February 22.—"The Technical Education Bill." By Swire Smith. Prof. Sir Henry E. Roscoe, M.P., F.R.S., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

February 14.—"Principles of Design, as applied to Bookbinding." By Henry B. Wheatley. Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., will preside.

Foreign and Colonial Section.

Tuesday evenings, at 8 o'clock:—

March 6.—"South African Gold Fields." By W. H. Penning, F.G.S.

Indian Section.

Friday evenings, at Eight o'clock:—

February 24.—"Facts regarding the religions of India, and their influences on the moral progress of the people." By Sir William W. Hunter, K.C.S.I., C.I.E., LL.D. The Earl of Northbrook, G.C.S.I., will preside.

Cantor Lectures.

The Second Course will be on "Yeast, its Morphology and Culture." By A. Gordon Salamon, F.I.C., F.C.S. Four Lectures.

Lecture III. — February 13. — The internal structure of the yeast cell.—Vacudes.—Granules.—Nuclei.—Nucleoli.—Gelatinous membrane.—Fat.—Composition of the cell.—Organic constituents.—Inorganic constituents.—Wort as a saprophytic food adapted to their supply.—Composition of wort.—Influence of malt upon composition and uniformity of wort.—The production of sterile wort.—Is it a necessity?—Is it possible upon the large scale?—Sterile wort as a medium for pure yeast culture.—The production of yeast from a single cell.—The test of purity.—Mode of preserving pure cultures.—The life of a yeast cell.—The transport of pure cultures.

Lecture IV.— February 20.— Pure yeast in the brewery.—Apparatus employed in its production upon the large scale.—Method of manipulation.—Results achieved.—Is the method available in high fermentations?—What advantages might it produce?—The products resulting from yeast growth.—Fermentation. — Historical retrospect. — The various theories.—To what extent are they reconcilable?—What practical advantages have been derived by their enunciation?

Professor Herkomer's Lectures.

The third and last lecture on "Etching and Mezzotint Engraving," will be delivered by Prof. Hubert Herkomer, A.R.A., on Thursday evening, February 16th.

Dr. Mann Lectures.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. Gordon Salamon, "Yeast, its Morphology and Culture." (Lecture III.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Randle F. Holme, "A Journey in the Interior of Labrador in 1887."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The Roman Conquest of Judæa."

Tuesday, Feb. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section). Mr. Henry B. Wheatley, "The Principles of Design as applied to Bookbinding."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." Lecture V.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Josiah Pierce, "The Economic Use of the Plane-Table in Topographical Surveying."

Photographic, 5A, Pall-mall East, S.W., 8 p.m. Annual Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Lord Brassey, "Recent Impressions in India and Australia."

Wednesday, Feb. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John Harrison, "Type-writers and Type-writing."

Meteorological, 25, George-street, S.W., 7 p.m. 1. Hon. Ralph Abercromby, "Electrical and Meteorological Observations on the Peak of Teneriffe." 2. Mr. W. B. Tripp, "Rainfall of South Africa, 1842-1886." 3. Mr. Nils Ekholm, "Some Methods of Cloud Measurements."

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Mr. J. Owen, "The Work of the Cymmrodorion."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Mr. S. Harding Terry, "Sea Water for Street Watering."

Thursday, Feb. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Extra Lecture.) Prof. H. Herkomer, "Etching and Mezzotint Engraving." (Lecture III.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. N. Ridley, "Self Fertilisation and Cleistogamy in Orchids." 2. Dr. John Rae, "Notes on the Birds and Mammals of Hudson Bay Territory."

Chemical, Burlington House, W., 8 p.m. 1. Prof. H. Debus, "The Analysis of Warkenroder's Solution, and an Explanation of the Formation of its Proximate Constituents." 2. Prof. Thorpe and Dr. Rodger, "Law of Mutual Development of Bromine and Chlorine." 3. Mr. C. M. Stuart, "The Action of Phosphorus Pentachloride on Salicylaldehyde." 4. Mr. Ward Coleridge, "Some Reactions of Nitrogen Chlorophosphuret."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Henry Blackburn, "Pictures of the Year."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert Parry, "Early Secular Choral Music." (With illustrations.) Lecture II.

Historical, 11, Chandos-street, W., 8½ p.m. Annual General Meeting.

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Dr. Payne, "Plagues, Ancient and Modern."

Friday, Feb. 17...United Service Inst., Whitehall-yard, 3 p.m. Colonel J. F. Maurice, "The Advantages of a Simple Drill Nomenclature, consistent for all Arms, apropos to an Incident of the Battle of Tel-el-Kebir."

Geological, Burlington House, W., 1 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir Henry Doulton, "Some Developments of English Pottery during the last Fifty Years."

Philological, University College, W.C., 8 p.m. Prof. Terrien de la Couperie, "The Illusions of Monosyllabism."

Saturday, Feb. 18...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture V.)

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FRIDAY, FEBRUARY 17, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

Committee.—Sir Douglas Galton, K.C.B., F.R.S. (Chairman of the Council), Sir Frederick Bramwell, D.C.L., F.R.S., W. H. Barlow, F.R.S., E. C. Robins, F.S.A., Col. A. E. Hamilton, R.E.

A conference will be held on this subject, by the Society of Arts, on Thursday, Friday, and Saturday, May 10th, 11th, and 12th, 1888. The following, amongst others, are subjects on which suitable papers will be received:—

1. History of the rise and progress of canal and inland river navigation in Great Britain and Ireland.

2. Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c.

3. The canals of other countries.

4. Present condition of canal navigation in Great Britain and Ireland. Suggestions for its improvement.

5. Canals and railways—their mutual influence on each other.

6. Comparative cost of transport by railways and by canals. Tariffs.

7. The law of canals, and matters relating thereto.

EXAMINATIONS, 1888.

The attention of secretaries of examination committees is drawn to the fact that the Society's Examinations, with the exception of that for Practical Music, will be held on the evenings of Monday, 9th April, Tuesday, 10th April, Wednesday, 11th April, and Thursday, 12th April. Committees having candidates for examination must apply on or before the 1st March to the Secretary of the Society of Arts, for a form whereon to make their application for examination papers. These forms must be returned not later than 12th March. Candidates desirous of being examined should apply to the secretary of any Institution in union with the Society, or to the Secretary of one of the Examination Committees. Programmes of the Examinations, with lists of the Committees, can be obtained on application to the Secretary of the Society of Arts, John-street, Adelphi.

CANTOR LECTURES.

The third lecture of the course on "Yeast, its morphology and culture," was delivered by Mr. A. Gordon Salamon, on Monday evening, 13th inst.

The lectures will be printed in the *Journal* during the summer recess.

LECTURES ON ETCHING AND MEZZOTINT ENGRAVING.

The third and last lecture of Professor Herkomer's series, which was devoted to the consideration of Mezzotint Engraving, was delivered on Thursday evening, 16th inst.

The lectures will be printed in the *Journal* at a later date.

BOOKBINDING EXHIBITION.

This exhibition, which was opened on Tuesday evening, 14th inst., will be closed to-morrow (Saturday). To-day and to-morrow the hours will be from 11 till 6. Admission free on presentation of visiting or trade card.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, February 7, 1888; Sir Francis Dillon Bell, K.C.M.G., C.B., Member of Council, in the chair.

The paper read was—

BRITISH COLUMBIA.

By Henry Coppinger Beeton,
Agent-General for British Columbia.

Vancouver Island was first discovered by Juan de Fuca, in 1592, who was sent on an exploring expedition by the Spanish Viceroy of Mexico to the North Pacific. The British Government, in 1776, offered a reward of £20,000 for the discovery of a practicable sea route between the Pacific and Atlantic oceans. Captain Cook was commissioned to conduct an expedition for this purpose, and in 1778 he roughly surveyed the coast, and landed at Nootka Sound. In 1790, Captain Vancouver, a former lieutenant of Captain Cook's, was dispatched on a diplomatic mission to Nootka Sound, to adjust differences between Great Britain and Spain. The Spanish Commissioner not having arrived, Captain Vancouver employed his time in surveying the Straits of Fuca and Gulf of Georgia, passing the strait which he named Johnstone's, rounding the north of the island on his return to Nootka Sound.

The mainland of British Columbia was visited in 1793 by Sir Alexander Mackenzie, an officer in the service of the North-West Company, who first penetrated the Rocky Mountains and discovered Fraser River. The North-West Company first formed their Indian trading posts in the north branches of the Columbia River in 1803. John Jacob Astor established his trading post at Astoria, at the mouth of the Columbia, in 1810; and in 1843 the Hudson Bay Company's chief factor, the late Sir James Douglas, founded Fort Victoria, erecting palisades and one bastion, after the pattern of the Hudson Bay forts, on the present site of the capital of the province.

The history of the Pacific Province of the Dominion may be said to have commenced with the charter granted to the Hudson Bay Company in 1849, leasing Vancouver Island, with the right of exclusive trading with the Indians, but stipulating for its colonisation. This most valuable clause in the charter was practically ignored by the Hudson Bay Company.

In 1858, the gold discoveries on the Fraser River took place, and in a few months some 20,000 people from all parts of the world flocked into the country.

The Hudson Bay Company's charter having expired, and with it the license of exclusive trade, active colonisation for the first time began.

Vancouver Island and British Columbia were now under the direction of the Colonial Office as separate colonies, administered by their respective governors appointed by the Crown. Victoria became the capital of the island, and New Westminster, on the Fraser River, the capital of the mainland. In 1866, the mainland and Vancouver Island were united under the name of British Columbia.

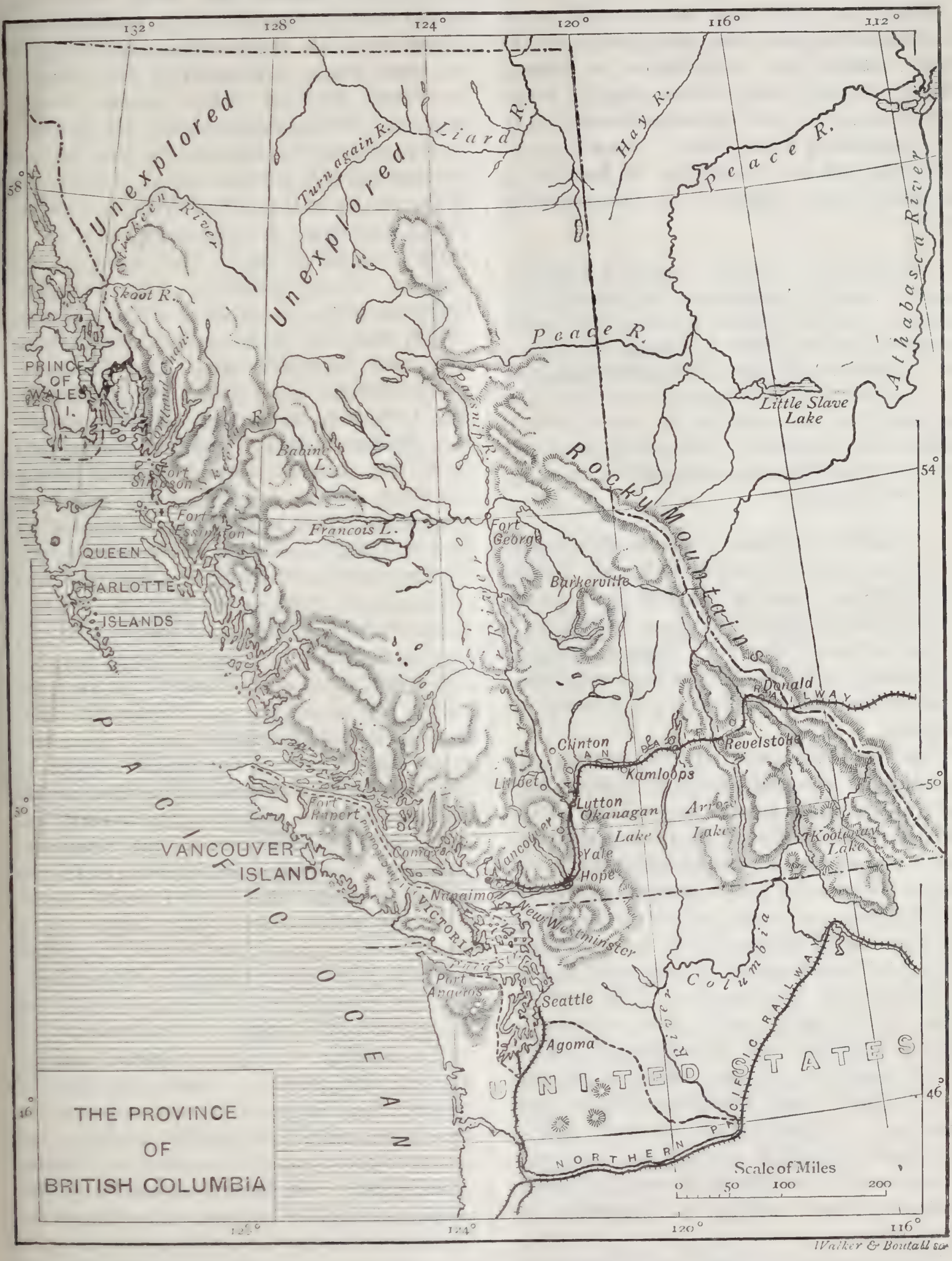
The confederation of British Columbia with Canada took place in 1871, the province stipulating for the building of the Canadian Pacific Railway. British Columbia, since confederation, is governed like the rest of the provinces of Canada under the British North America Act of 1867, having its Lieutenant-Governor appointed at Ottawa, and an Executive supported by a majority of the Local House.

The province of British Columbia is bounded on the north by the 60th parallel of North latitude, on the south by 49th parallel (the United States boundary), on the east by the Rocky Mountains, and on the west by the Pacific Ocean. It consists of Vancouver and Queen Charlotte Islands, and the mainland, including the smaller islands in the Straits of Georgia, containing an area of 350,000 square miles, equal to the States of California, Oregon, and Washington Territory combined. The country exhibits the diversified and bold physical features peculiar to the whole cordillera region of the west coast of North America, of which it forms a part.

Broadly speaking, there are two grand divisions of the country—the humid forest region of the coast, and the dry grazing region of the mainland.

The climate of British Columbia is one of its most attractive features, being much more temperate than the climate of any part of Canada east of the Rocky Mountains. The island climate very much resembles the south of England. Captain Vancouver, when he visited it, gives the following general description:—"The serenity of the climate, the innumerable pleasing landscapes, and the abundant fertility that unassisted nature puts forth, requires only to be enriched by the industry of man with villages, cottages, mansions, and other buildings, to render it the most lovely country that can be imagined, while the labour of the inhabitants would be amply rewarded by the bounties which nature seems ready to bestow on civilisation."

Dr. G. M. Dawson, in his evidence before a Parliamentary Committee, described Van-


THE PROVINCE
OF
BRITISH COLUMBIA
Unexplored
Unexplored
Liard R.
Turn again R.
Hay R.
Peace R.
Peace R.
Athabasca River
Skoot R.
PRINCE OF WALES I.
Babine L.
Fort Simpson
Fort Essington
Francois L.
Fort George
Barkerville
Rocky Mountains
Little Slave Lake
QUEEN CHARLOTTE ISLANDS
PACIFIC OCEAN
VANCOUVER ISLAND
Fort Rupert
Nanaimo
VICTORIA
New Westminster
Clinton
Lillooet
Lytton
Kamloops
Okanagan Lake
Yale
Hope
Donald
Revelstoke
Arrow Lake
Kootenay Lake
Port Angeles
Seattle
Columbia
UNITED STATES
NORTHERN PACIFIC RAILWAY
Scale of Miles
0 50 100 200
132° 128° 124° 120° 116° 112°
58° 54° 50° 46°
Walker & Boutall sc.

couver and the coast generally as possessing a mild and agreeable climate, arising from the fact of the Pacific Gulf Stream striking the coast at this point, bringing with it the warm tropical waters.

There is very little frost or snow in Victoria. An abstract of one year gives buttercups in flower, March 29; strawberries in bloom, April 13; apple trees in bloom, May 6; beans in blossom, May 12; strawberries ripe, May 25; raspberries ditto, July 9. The climate of Victoria, and its suitability for invalids is described by a traveller in the following words:—

"Victoria has a climate unequalled anywhere, which is specially recommended to health-seeking invalids. The atmosphere is charged with ozone peculiar to Victoria only. It originates in the snow-cooled breezes in the Olympian range in Washington territory (about 60 miles south-west of the city), mixes with the salt sea air of the Pacific, giving it peculiar health-restoring and life-prolonging qualities which will make Victoria, some day, the sanitarium of the Pacific coast."

A pamphlet published under the direction of the Government of British Columbia divides the interior or mainland part of the province as to climate into three zones:—"South," "Middle," and "North." But boundaries of this nature cannot be defined with exactness, owing to the effects of the irregularities of the surface.

The "southern zone" lies for the most part between the 49th and 51st parallel North latitude. The mean annual temperature of the southern zone differs little from that of the coast region, but a greater difference is observed between the mean summer and winter temperatures, and a still greater contrast when the extremes of heat and cold are compared. The total precipitation of rain and melted snow in the low lying portions of the southern zone is extremely small; for instance, at Spence's Bridge, on the Thompson River (700 ft. above the sea) the rainfall in 1875 was only 7·99 in., total, including melted snow, 11·84 in.; at Esquimault, southern part of Vancouver Island, it was 35·87. This small precipitation gives rise to the open or lightly-timbered grass country, so favourable for stock raising.

With irrigation, the land in this section of the mainland will yield heavy grain crops.

The "middle zone" is placed between 51° and 53° North latitude. This zone, owing to the occurrence within it of the high mountains west of the Columbia, and in the big bend formed by that river, and also of the great mass of the Cariboo Mountains, includes more of the Rocky Mountain climate than do the zones north or south of it. Dense forests are spread over large portions of it, marking considerable rainfall. At about the 122nd meridian the lands begin to descend in the valley of the Fraser, and the climate correspondingly improves. Professor Macoun tells me he found grains growing in this middle zone on the benches along the Fraser valley, at intervals, all the way up to Quesnelle. Wheat and barley were a good crop; this was in 1872-5.

The "northern zone" lies between 53° and 60° North latitude. The Canadian Government has no weather stations in this region, and very little accurate information has been recorded. Mr. John Macleod, an experienced chief factor of the Hudson Bay Company, states that, generally speaking, between the 53° and 56° North latitude, the climate may be called mildly Canadian, with a more luxuriant growth of vegetation. This statement is confirmed by Professor Macoun, who informs me that on the Nichaco and Stuart rivers he found luxuriant grasses, and everything showed a fairly warm summer climate. He was there on June 5th, 1875, and crossed the same rivers on the 18th November, 1872, on the ice. That year the winter set in on the 5th November. Dr. Dawson makes the arable land to be about 37,000 square miles. The greater portion of this is in British Columbia. The whole region Professor Macoun pronounces to be very rich. The prevailing character of the Kootenay, Okanagan, and Chilcotin country is (1) the deep river valleys and bench (terrace) lands, especially where covered with bunch grass, which has now given place in part to pasture sage. (2.) Ascending the slopes of the valleys, excellent pasturage is found at all times, but the higher up the longer it keeps green. (3.) Still ascending, we enter a plateau, sparsely covered with trees, but having the best of pasture. (4.) Higher still we enter a more or less dense forest of Douglas Fir, and the grass ceases to grow, except in patches in the more open spots. The general character of the interior region, or plateau, is as follows:—Short thin grass on the benches, increasing in quantity as we ascend, then a scattered forest of yellow pine passing into Douglas fir, which becomes continuous above 3,000 feet, though large areas above that produce excellent pasturage. These plateaux are almost level, and

for the most part pasture land, being lightly wooded, and affording summer pasturage in abundance. All the country, from Cache Creek southward, including the valleys of the North and South Thompson, Kamloops, Nicola valley, and the Okanagan valley, is either natural pasture or fitted for agriculture, with here and there patches of thick forests.

The richest and most important agricultural section of the province is in the Delta of the Fraser River, which extends from the south arm of the river on the east, to the Gulf of Georgia on the west, embracing within its borders some of the finest lands of the Pacific coast, comprising about 40,000 acres, yielding heavy crops of Timothy hay, oats, barley, wheat and fruit, also dairy produce.

Spullamcheen and Okanagan valleys grow wonderful grain crops.

The island of Vancouver, 300 miles long, with an average breadth of 50 miles, containing an area of 14,000 square miles, lies parallel to the coast of the mainland, with the Strait of Georgia, and numerous islands between. The northern half is comparatively unknown. The principal settlements are upon the south and east coasts, where the soil is exceeding fertile and favourable to agriculture and fruit growing. The island is more or less mountainous, heavily timbered and studded with lakes, but with many grassy prairies or little parks. Cowichan, Comox, and Nanaimo on the east, and Alberni on the west coast of the island, are good farming districts.

The capital, Victoria, is at the south-east extremity of the island, with a population of upwards of 12,000. It is also the commercial and distributing centre for the province. A large and increasing number of tourists from the Mother Country, Canada, and California, arrive in the summer and autumn months by the Canadian and Northern Pacific Railways, attracted by the salubrity of the climate and the charms of the landscape. The neighbourhood of Victoria has good macadamised roads, which contrast favourably with the cities on the American side of the boundary.

Victoria has the advantage of being served by two of the trans-continental railways, bringing it within a fortnight of London. The Canadian Pacific Railway connecting on the Atlantic with the Allan line of steamers at Montreal, and the Northern Pacific with the Cunard from New York. The Oregon and California Railway is now completed to Puget Sound, which will bring San Francisco within two days of Victoria.

The city of Nanaimo has a population of about 4,000, and with the district around, and the mining village of Wellington, together form the seat of the coal mining industry of Vancouver Island. The city fronts upon the harbour, and the wharves regularly receive steamships from San Francisco, Portland, and Alaska, as well as from Victoria, New Westminster, and other coast ports. Departure Bay is three miles north of Nanaimo, a picturesque inlet of the Gulf of Georgia, forming a perfect harbour with deep water at all tides, and is the shipping port of the well-known Wellington coal. Messrs. Dunsmuir and Sons, are the proprietors of this mine.*

The Esquimault and Nanaimo Railway, with terminus in Victoria, connects the harbours of Esquimault and Victoria with Nanaimo, and will doubtless afford excellent coaling facilities for the mercantile marine frequenting Victoria and Esquimault harbours, including the new line of steamers running between Vancouver City, Hong Kong, and Yokohama.

The country on the line of the railway, although heavily timbered, and hilly, is being prospected by the company, who have just come into possession of their land grant. From recent conversation with Mr. Robert Dunsmuir, the public-spirited president of the company, I am justified in saying that liberal terms will be granted to intending settlers. I noticed along the line of railway, while travelling this summer, evidences of the commencement of active settlement.

A northern extension of the railway is now under consideration, by means of which 3½ millions of acres at the disposal of the Government, literally unexplored, would be opened up for settlement by an agricultural lumbering, and mining population, thus developing these different resources of the country. The development, also, of the resources of the adjacent islands — chief among them, the Queen Charlotte group—would be stimulated, and the coal and other mineral deposits known to exist; likewise the cod-fishing industry could be made available.

It is proposed, also, to extend the island railway from Victoria to a point opposite Port Angelos in Washington territory, to connect by a transfer boat at the narrowest part of the Straits of Fuca with the American

* The other collieries on the island are the property of the Vancouver Coal and East Wellington Companies.

railways. This would materially assist the development and settlement of the whole of Vancouver Island, and place Victoria in a most commanding position as a commercial and distributing centre. My account of Vancouver Island would be incomplete without reference to the harbour of Esquimault, three miles from Victoria, which is capacious, easy of access, nearest to the ocean, and well sheltered. It was selected at an early date by the British Admiralty, for the healthiness of its locality, as the chief naval station for her Majesty's ships on the Pacific. It has its dockyard, arsenal, naval hospital, and the last addition its graving dock, capable of taking in the largest man-of-war.

The importance of Esquimault to Great Britain, as a coaling-station, and also from a strategic point of view, is obvious, as from this depôt her fleets can readily proceed to any part of the Pacific.

Queen Charlotte Islands lie some 200 miles north-west of Vancouver Island. They comprise over 150 islands and islets, their united length being 156 miles, and greatest width 52 miles. Moresby and Graham are the two principal islands of the group. Under the direction of the Dominion Government the waters and shores of the north and east coast of the islands have been partially examined, but little is known of the west coast. These islands, in common with all those lying off the north-west of the continent, are evidently the mountain tops of a submerged land, separated from it by a mighty volcanic upheaval, by the sinking of the earth's surface, and the inflowing of the waters of the ocean, forming the most remarkable labyrinth of inlets, sounds, straits, and channels on the face of the globe.

The climate of these islands is mild, owing to the influence of the warm Japan current. There is comparatively little open agricultural and grazing land, the greater part of the surface being covered with dense forest. The resources, so far as known, are fish, furs, and timber; halibut, herring, salmon, and dog-fish are caught in unlimited quantities. Extensive black cod and halibut banks exist. The waters at the entrance of the Skidegate inlet are the greatest known resort of the dog-fish on the coast. The works of the Skidegate Oil Company extract 35,000 to 40,000 gallons of refined oil annually.

Numerous veins of coal have been discovered on Moresby and Graham Islands, but the most important are the anthracite deposits on Seymour Mountain, in Skiedegate Inlet, the only anthracite coal, so far, found on the Pacific coast. This mine has been partially developed by the Queen Charlotte Coal Mining Company, and a vein of good anthracite coal, from 3 feet to 6 feet in thickness, was found. There are deposits of gold and copper, but so far, they have not been worked.

Mr. Chittenden, in his official report to the British Columbia Government in 1884, says:—"No country which I have ever visited affords greater natural resources of food supply from the sea and forest."

We will now visit the mainland cities. New Westminster, on the north bank of the Fraser River, about sixteen miles from its mouth, has a population of 4,000; the site is commanding, and on a sunny slope to the river, altogether healthful and pleasant. It is the chief seat in the province of the salmon-canning industry, which has developed considerably. The branch railway to Port Moody connects it with the Canadian Pacific Railway. Good substantial blocks of building, of stone and brick, are now replacing wooden structures of pioneer days, and the city has a solid and progressive look. It is situated in the centre of the finest agricultural district in the province.

Vancouver, the terminal city of the Canadian Pacific Railway, has already made rapid strides, and is likely to become a city of importance.

On its present site, little more than two years ago, stood an Indian village in the pine forest, the only sign of civilisation and industry being the saw mill of the Hastings Company and its logging camps. To-day you have a young city, the surface cleared and gently sloping from the centre to the water, situated on a small peninsula formed by two arms of the sea, Burrard Inlet on the north and False Creek on the south. The harbour, on the north side, is three miles at its widest, and twelve miles in length, landlocked, and well sheltered. As soon as the agreement between the Government of British Columbia and the Railway Company for the transfer of land subsidy was completed, and Vancouver fixed as a terminus in the spring of 1886, people began to flock in, and very soon a town sprang into existence, and building began with the greatest energy. The city was incorporated on the 6th April, 1886. On 13th June following, it was destroyed by fire; and but two days after, numerous tents and small huts were to be seen dotting the town site; the work of re-building commenced, and within six months over 500 buildings were erected, many

of them substantial two and three storey frame blocks, and a large number built of brick. A sure sign of the confidence felt in the future importance of the city, is that since the fire over 1,000,000 dollars have been expended on building alone, and some fine brick and stone blocks have gone up. To-day the population numbers about 6,000.

The Canadian Pacific Railway Company has built a handsome hotel for the accommodation of its passengers, and is erecting wharves, warehouses, and workshops for its special requirements. During the first half-year of the opening of this new route with China and Japan, 120,000 packages of tea, value $2,250,000 were forwarded by the railway, the beginning of a large and increasing commerce with the East, which will be supplemented later by our Australian and New Zealand colonies.

The completion of the Canadian Pacific Railway, uniting the Atlantic and Pacific oceans, has added greatly to the geographical and commercial importance of the whole Dominion, and must greatly stimulate the growth and development of her Pacific province. Within four or five days of Montreal, six of New York, and a fortnight of London, British Columbia has already begun to attract population, capital and enterprise, both from the Mother Country and the United States. The increase of population for the year ending 31st December, 1886, was between 11,000 and 12,000; about a third of this number settled along the line of the Canadian Pacific Railway from Donald in the Rocky Mountains to Victoria. Of the remaining 7,000, more than one-half took up homesteads in the New Westminster and other districts on the mainland, leaving about 3,000 settlers for Vancouver Island, who would probably take up land in the agricultural districts of Cowichan, Nanaimo, Comox and Alberni. Nearly, 300 pre-emption records were issued for these districts, covering an area of about 50,000 acres. The next decade should see a much greater advance in the material progress of the province, particularly if the quartz mining industry proves a success.

The exports of the province for the year ending 30th June, 1887, were as under:—

Produce of the mines—	
Gold dust and bars	$684,689.00
Coal	1,137,618.00
Iron ore	521.00
	1,822,828.00
Produce of the fisheries	910,559.00
,, forest	234,109.00
Furs and skins	380,126.00
Manufactures—	
Agricultural and miscellaneous	118,845.00
Total	$3,466,467.00

Estimating the entire population at 80,000, makes the amount per capita double that of the older provinces of the Dominion.

Coal

The importance and value of the coal fields on the east coast of Vancouver Island, as a factor in determining the future of the province, cannot be exaggerated. For supplying her Majesty's ships at Esquimault, and also the mail steamers that now run in connection with the Canadian Pacific Railway to China and Japan, and in the near future to Australia, the situation of Nanaimo, the Newcastle of British Columbia, is most convenient, and what may be of still greater importance some day is the existence of iron in close proximity to the coal. Iron is found in many localities; on Texada Island, and near Nanaimo there is a mountainous mass of iron ores traceable for miles. Dr. Selwyn describes these as some of the finest ores known in Canada. Dr. Dawson describes the bed on Texada Island as "a very rich magnetic ore assaying 68·4 of iron," with a very low per-centage of phosphorus and other impurities, "and having only twenty miles of the navigable water of the Strait of Georgia between it and the Comox coal field, and both the iron and coal close to the water's edge." The deposits are very widely spread both on the mainland and in the islands, the bituminous coal of Nanaimo being the best on the Pacific coast.

Thirty-two different places are named by Dr. Dawson in a Report on Mines, published by the Dominion Geological Survey, in which coal and lignites are known to occur, and some of them are extensive districts. Those on the mainland are in the Nicola valley, and on the North Thompson. The tertiary coal measures underlie nearly 1,000 square miles about the estuary of the Fraser River. In the Nicola section the coal-bed is over 100 miles in length, and 40 miles in width. The coal area of the east coast of Vancouver Island, to which the Nanaimo mines belong, is 130 miles in length, and is already largely worked.

The favourite household coal of San Francisco is the Wellington, which, in spite of a protective duty of 75 cents per ton, has a ready

sale. The exports in 1886 were 326,636 tons, shipped to San Francisco, Portland, Alaska, and Honolulu, and supplied to mail steamers and other ships calling.

Gold.

The Minister of Mines gives the total yield of gold for the year ending 1886 at over $903,000, being a substantial increase of $190,000 over 1885, and the number of miners employed, 3,147, as against 2,902 in 1885; the average yearly earnings of 1886, $287 as against $246 in 1885. The alluvial mines of Cariboo have yielded in the past some ten millions sterling. The recent reports of the Dominion and Provincial experts who have inspected our quartz ledges, justify the belief that British Columbia is about to repeat the history of all other gold countries. Those most competent to judge believe the province is now on the eve of demonstrating the economic value of her gold and silver quartz mines. The great advance science has made of late years in the treatment of ores will assist materially in developing the gold and silver mines which are known to exist in the Selkirk and Cariboo Mountains, and also in the Nicola and Kootenay districts.

Fisheries.

The Government report for 1886 gives the result of the fishing industry of the province, including the estimated consumption by the Indian population, as amounting to the total value of $4,834,848; capital invested, $872,445; number of men employed, 6,211.

Of preserved or canned salmon last year between 9,000,000 and 10,000,000 lbs. weight were shipped to Europe, Canada, and Australia. The total value of this industry since its commencement ten years ago cannot be less than a million and a-half sterling. To keep pace with the increasing demand for canned salmon in home and foreign markets, it behoves the authorities and all persons engaged in this valuable industry to devise means to open other streams closed by mill dams or natural falls, for natural breeding, and also to increase the facilities for artificial propagation.

A new industry has sprung up in the shipment of fresh fish packed in ice. A large building containing 500 tons of ice has been erected in New Westminster, and fitted up with freezers of 50,000 lbs. capacity. In Victoria there is between 700 to 1,000 tons of ice stored, and the experiment of bringing the black cod as well as other fish into the Eastern markets in a fresh condition will be tested.

British Columbia yields roundly 30,000,000 pounds more fresh, smoked, and canned salmon than all the provinces of the Dominion put together.

Mr. Thomas Mowat, in concluding his report last season to the Ottawa Government, on the deep sea expedition around the coast of British Columbia in search more particularly for the black cod banks, says :—

"On the coast of British Columbia with its 7,500 miles of sea shore, studded with numerous islands, and lined with bays and fiords, some of which extend many miles inland, making numerous safe harbours for all sized crafts, the variety of fish and mammals which abound, the mildness of the seasons, the facilities for procuring wood and water, all point to a most favourable location for a colony of fishermen. One thing is sure, no one need starve for want of food."

In this connection I should like to mention that my Government have, for some time past, had under their consideration the question of founding crofter colonies on the coast of the mainland, and on the east coast of Vancouver Island, which, if successful, will be a great boon to the congested districts on the west coast of Scotland, and likewise in developing the fisheries of British Columbia. The proposal, by way of a beginning, is to deal with 1,500 families — equal to 6,000 souls — each family to have 50 to 100 acres of cultivable land, and thus continue their old avocations of fishing and farming.

As these crofters are in an impoverished and destitute condition, it will be necessary for the local Government to advance their passage money, and likewise provide food and shelter until they become self-supporting. Mr. Alexander Begg, the Special Commissioner deputed last autumn by the British Columbia Government to effect this object, has recently returned to Victoria to lay the result of his mission before the local Government. He has succeeded in enlisting the interest and co-operation of the Home Government, who are willing to advance the necessary funds, subject to the guarantee of the Provincial Government. Mr. Begg is sanguine of success. When thinking of recent unhappy events in the island of Lewis, we must, I am sure, wish him "God speed" in his enterprise.

Mr. H. Yondall, who has had great experience in the Newfoundland and Labrador fisheries, and formed part of the expeditionary

party sent out in September, 1886, to the west coast of Vancouver and Queen Charlotte Islands, says:—"I have no hesitation in saying that the waters of the province, particularly the west coasts of Vancouver and Queen Charlotte Islands, are actually teeming with valuable food fishes, as well as with others which are valuable for various purposes of commerce. Halibut, I should say, is the most abundant species. The black cod is by far the finest and most valuable fish on the coast. It attains a weight of from 20 to 25 pounds, a quart of fine oil, having the appearance of melted butter, can be taken from an ordinary sized fish, say 18 pounds weight. The fish has a fine flavour, and is highly prized. I feel sure that the black cod, wherever introduced, would command a ready sale. It would be a valuable addition to the industries of the province."

The Canadian Pacific Railway, with its numerous connections and branch lines, as well as the network of railways through the United States, will open markets for all these products. The inhabitants of the South American Republics are a fish-consuming people, as well as Brazil and the West Indies. Australia would also take our cod, halibut. &c., as well as our salmon.

The Fur Seal Fishery has attained a wonderful development within the last few years. The twenty schooners engaged in this industry represent a total of 1,216 tons, with 175 boats and canoes. The total catch of skins for 1886 was 38,917, value $194,585. The sealers hunt off the California coast in the spring, and go north to the Behring Sea in summer.

Furs and Skins.

The furs and skins of the province are dealt in chiefly by the Hudson Bay Company, who have their Indian trading posts or stations scattered over the province. There are a few private firms in Victoria, also in the fur trade. The exports of furs and skins in 1886 amounted to $329,248. In connection with the exports of furs and skins, I am reminded of the Indian population.

Indians.

The Dominion Government has the whole charge of the Indians throughout the country, At the head of the department for Indian affairs is the Right Hon. Sir John A. Macdonald, who with the Deputy Superintendent-General and a staff of officers and *employés* superintends the work at Ottawa. The provinces and districts have each its Indian superintendent and agents. British Colombia has seven Indian agencies extending over the islands, the north-west coast, and the interior of the mainland. The total Indian population, roughly speaking, is 38,000. They are divided into numerous tribes, and the tribes into smaller bands. The coast Indians live mostly by hunting and fishing, not caring to cultivate their land reservations, except potato patches. They hunt the grizzly bear, and trap mink, marten, and sea otter with success. The younger members seek employment in logging camps, and also in the hop-fields south of the boundary line. The mainland Indian is of superior type and better physique, leading very much the agricultural and pastoral as well as the hunter's life, grows his crops of wheat, oats, barley, and potatoes, and owns cattle, horses, sheep, cows, and pigs. Their habits are more active and their lives healthier than the coast Indians, both men and women riding much on horseback. The younger men are employed as herders and packers, and collect a considerable quantity of gold, particularly when the run of salmon is short and the rivers dry.

The total expenditure for the Indian service in British Columbia was, in 1886, just under $32,000. School teachers are provided by the Government, and the different churches have their missions at most of the Indian villages. The Indians of British Columbia are, as a rule, peaceable, law-abiding, and friendly towards their white neighbours. Their numbers are perceptibly decreasing, particularly the coast Indians, due mainly to the degradation of their lives, accelerated, sad to say, by contact with the worst vices of the white settlers. It is a relief, after dwelling on the dark side of the picture, to know they have their industrial exhibitions after the European fashion. One, held the year before last at Cowichan on the east coast of Vancouver Island, was attended not only by neighbouring Indians, but by many settlers, who were greatly interested and surprised at the excellence and extent of the productions shown. About three hundred entries were made, thirty being for grain, the samples of which and of root crops would have stood high in any provincial exhibition. The chief "Zohal" was presented by the Indian superintendent with a silver medal in recognition of his efforts.

Timber.

The most important trees comercially are the Douglas fir, Menzies fir, yellow cypress,

and, in hard woods, the large-leaved maple.

Examples on a large scale of the Douglas fir, known commercially in England as Columbian pine, were shown in the large trophy in the Canadian Court of the Indian and Colonial Exhibition from the Hastings Sawmill.

The Menzies fir attains large dimensions in the northern part of British Columbia. In the northern part of Vancouver Island and the mainland, the yellow cypress is also seen at its best.

One of the earliest applications of the Douglas fir in London is to be seen in the Board-room of the Equity and Law Life Assurance Society, in Lincoln's-inn-fields.

The two botanists to whom we are most indebted for a knowledge of the vegetation of the north-west coast of America are Archibald Menzies, who was appointed surgeon and naturalist on the voyage of Vancouver in 1790, and Dr. Douglas, who was engaged by the Horticultural Society of London to proceed to the north-west coast in 1824, and again in 1829, where he remained until 1834.

Mr. Menzies' appointment is named by Captain Vancouver in his introduction to the account of his voyage. The collection of plants received much consideration. "For the purpose of preserving such new or uncommon plants as Mr. Menzies might deem worthy of a place among his Majesty's very valuable collection of exotics at Kew, a glazed frame was erected on the after-part of the quarter deck for the reception of those he might have an opportunity of collecting."

There are very many who may desire to have a full knowledge of the researches of David Douglas. In the words of the late Sir W. J. Hooker, "Throughout Europe and in the United States of America, there is scarcely a spot of ground deserving the name of a garden which does not owe many of its most powerful attractions to the living roots and seeds which have been sent by him (David Douglas) to the Horticultural Society of London."

Every part of British Columbia is amply and well provided with excellent wood for construction and other purposes. The coast region has the prominence at present, owing to the greater facility for export. The gigantic size of the forest is due, Dr. Dawson says, to the mildness and humidity of the climate. He specially mentions the cedar as a tree of exceeding value, sometimes attaining a diameter of 17 feet, although the largest specimens are apt to be more or less hollow. The Indians make their well-known magnificent canoes of these large cedar trunks. The spruce, an excellent wood, is not so soft as the wood of the eastern provinces, and of different species. White pine, different also from that of the east, producing equally good wood, but, as a rule, so far from the sea that it has not been utilised to any great extent. The hemlock grows to a much greater size than in the east, and yields good clean lumber. This tree is found along the whole coast and over a considerable portion of the interior. On the Queen Charlotte Islands it is found 200 ft. in height. Yellow cedar or cypress wood, which is found in the northern parts of the coast, is an exceedingly fine wood for cabinet-making, being a close wood, very durable, penetrated by a resinous substance that protects it from decay, and gives out a peculiar odour. The yellow pine found on the dry southern part of the plateau in the interior, is locally a tree of very great value. Dr. Dawson says the wood is preferred even to the Douglas pine, where that occurs in the neighbourhood.

The two principal lumber mills engaged in the export trade are the Moodyville and Hastings mills, on Burrard Inlet. The annual out-turn of rough and dressed lumber from these mills is about 28,000,000 superficial feet, shipped mostly to Australia, South America, the Cape, and China.

There are other saw mills at New Westminster, Victoria, and Chemainus which supply the local demand. One of the most striking objects in the Canadian Court of the Colonial and Indian Exhibition of 1886, was a large, longitudinal section of Douglas fir, measuring 15 ft. 1 in., by 7 ft. 8 in. in breadth, and 8 in. in thickness, sawn from a tree 300 ft. high, with a girth of 25 ft., taken from a logging camp on the east coast of Vancouver Island.

The northern portion of the mainland and the Kootenay district will, in the future, become important centres for supplying the treeless region of the north-west territory with lumber.

Fruit Raising.

Fruit raising promises to become an important industry. Of the capabilities of British Columbia to produce fine fruits, visitors to the Colonial Exhibition must have had ample proof. The apples, pears, and peaches preserved in jars, and displayed on the agri-

cultural trophy, were of remarkable size, and in the show of season's fruits from the different provinces of the Dominion, on view in the conservatory during the last days of the Exhibition, it was generally conceded that the apples of the Pacific province carried off the palm.

Professor Macoun says "Perhaps there is no better place in the world for raising fruits than in the neighbourhood of Victoria. Apples and pears of a very large size are produced in such abundance that the former can hardly be sold at any price."

The islands in the Straits of Georgia grow fine grapes, melons, and peaches, so does the southern interior of the mainland.

The Marquis of Lorne, when Governor-General of Canada, visiting Victoria in 1882, said in a speech:—"There is no reason why British Columbia should not be for this portion of our territory what California is to the States in the supply afforded of fruits. The perfection attained by small fruits is unrivalled."

Mr. John Jessop, of the Immigration-office in Victoria, writing to me, says:—"An immense and inexhaustible market is now opened up with the territories and provinces as far east as Lake Superior not only for fruit, but for British Columbia lumber and fish likewise."

Education.

In the all-important matter of education, British Columbia compares favourably with the older provinces. It is due to the local Government to state that it has been fully alive to the importance of making liberal provision for the education of the rising generation. It may be said generally that the schoolmaster follows close upon the heels of the settler. Practically the Government places a good free common school education within the easy reach of every child. A school is established wherever and whenever there are fifteen children of school age—six to sixteen inclusive—within three miles of a common centre.

Free high schools are also established and maintained in the principal centres of population, the limiting condition being the presence of not less than twenty pupils possessing the requisite scholastic qualifications.

The Canadian Pacific Railway.

This railway is Great Britain's North American highway to China, Japan, and Australia, and will become one of her important trade routes. The belief of our countryman, John Cabot, the great sea-king and discoverer of the New World, in a north-west route to the east, has in our day come to pass, not, as he supposed, round the Continent by sea, but across the Continent by land.

Jacques Cartier, the French navigator, when he ascended the St. Lawrence in 1534, and took possession of the country in the name of France, left on record the belief as to the direction in which his course lay by giving the name "La Chine" to the present village near the Great Rapids.

Lord Selkirk, in 1812, never imagined, when he planted his little colony of struggling and half-starved crofters from the western highlands of Scotland on the then isolated banks of the Red River, in the Canadian north-west, that it would grow into the present city of Winnipeg, with its population of 30,000, and that later on it would furnish one of the important links in the chain of the great Canadian enterprise.

While giving full credit to the Canadian Government for its energy and determination in overcoming great difficulties, we ought at the same time to acknowledge the valuable services of the pioneers in this great enterprise—I mean such men as Major Robert Carmichael Smyth, who, in 1849, in a letter to Judge Haliburton (Sam Slick), wished to emphasise his meaning by adopting the following title for his pamphlet:—"The Employment of the People and Capital of Great Britain in her own Colonies, explained in a letter from Major Robert Carmichael Smyth to his friend, the author of the 'Clockmaker,' containing thoughts on the subject of a British Colonial railway communication between the Atlantic and the Pacific, from the magnificent harbour of Halifax in Nova Scotia (north-eastern America), to the mouth of Fraser River, in New Caledonia (north-western America), at the same time assisting emigration."

Another pioneer, the late Mr. Alfred Waddington, who, after spending much time and money in exploring the best route for the railway from the coast to the Rockies, came to London, and made repeated efforts to enlist the sympathy and support of her Majesty's Government. I well remember the able and interesting paper he read at a meeting of the Royal Geographical Society, presided over by Sir Roderick Murchison, in the spring of 1868, "On the Geography and Mountain Passes of British Columbia in connection with an Overland Route."

After spending some time in London, and finding the Government unwilling to help, Mr. Waddington left for Ottawa, to see if he could succeed better with the Dominion Government; and, with this object, he addressed a meeting of the members in one of the rooms in the Parliament building.

The Canadian Pacific Railway Company was incorporated in February, 1881, work begun in June, 1881, and the line completed in November, 1885 — five years in advance of the contract time. The distance from Montreal to Vancouver is 2,905 miles. By the recent opening of the St. Lawrence Bridge at Montreal, and the Atlantic and North-West Railway, there is a saving of distance to the Atlantic coast, viz., 103 miles to Halifax, and 281 miles to St. John, New Brunswick. When the new mail contracts for the Atlantic and Pacific services are working, which may be expected in about eighteen months, the distance from London, *viâ* the Canadian Pacific Railway, will be reduced to 27 days to Yokohama, 32 days to Shanghai, and 35 to Hong Kong.

The new Atlantic service will have first-class steamers running to Quebec in summer and Halifax; in winter, and for the Pacific, the Canadian Pacific Railway Company will furnish first-class steamers, constructed under Admiralty supervision, in such a manner as to render them convertible into armed cruisers, with a maximum speed of 17 knots. Victoria, the capital of British Columbia, will then be only 12 days from London.

While speaking of this accelerated service, I am reminded of the latest achievement in telegraphy, which has made a conversation practicable between Vancouver and London! Some of my hearers may have read of the midnight talk on the 22nd of last month, between Messrs. Norman and Stead. The Special Commissioner of the *Pall Mall Gazetté*, who is now making a tour of the world, previous to leaving British Columbia for Japan, gave his impressions of Canada in a three hours' conversation with his chief in London, over the Canadian and Commercial Cable Company's wires. A marvellous stride since Wheatstone first made the telegraph speak between Camden and Euston.

The Canadian Pacific Railway has an advantage over the Union and Central Pacific and Northern Pacific lines, in having the whole line under one management, shorter mileage, and much easier gradients.

The British Columbia section, from the Rocky Mountains to the Pacific sea-board, is the most picturesque part of the Canadian Pacific Railway, having mountain, lake, and river scenery, not surpassed on any railway in the world. Leaving the harbour of Victoria in a commodious and well-appointed steamer, after a pleasant run through the islands in the Straits of Georgia, you arrive at Vancouver, where the east-bound train is waiting. At starting, the railroad first skirts Burrard Inlet, a large handsome sheet of water, then follows the north bank of the Fraser River through a fine farming district, until the blue waters of the Harrison River are reached. This is the entrance to the Cascade Range of mountains, and where the grandeur and beauty of the scenery commences. Yale, 110 miles from the mouth of the Fraser, at the head of uninterrupted navigation, is next reached, and, looking down, you see the canon of the Fraser River and its seething torrent rushing headlong through narrow gorges. Continuing along the Fraser, forty-four miles further, is Lytton, at the junction of the Thompson and Fraser Rivers. The railway then traverses a grazing district to Kamloops Lake, and on for some distance along the Shushwap Lakes, wirh their mountain sides heavily timbered; next, Eagle Pass, through the Gold Mountains; the railway then skirts the Selkirks, climbing up the mountain side, through dense forests of enormous trees, until near the summit you are in the midst of a wonderful group of mountain peaks of fantastic shapes and colours. The marvels of railway engineering are to be seen in the Selkirk Mountains, as the train, with a lessened speed, goes over trestle bridges of giddy height, and looking back, you see the sharp curves and snake-like windings of the part just traversed. The summit of this range is 5,500 feet, a broad level area, where stands the "Glacier" Hotel (inviting quarters for the tourist and sportsman), surrounded by mountain monarchs and glaciers. Following the Beaver, and crossing the Columbia and Kicking Horse Rivers, brings you to the Pass of the Rocky Mountains. This is the steepest grade on the whole line. Extra engines of great weight are necessary, and special precautions in the way of four safety switches every two miles are in use.

The fields of snow and ice remind us we are nearing the great elevation of the Rockies, with the mountains five to seven thousand feet above, stretching away to the north-west and south-east, forming the great backbone

of the Continent. The great "divide" is here formed by two little streams; the one finds its way to the Saskatchewan and Hudson's Bay to the Atlantic, and the other flows to the Pacific through the Columbia River.

The traveller by the Canadian Pacific Railway finds himself in a short fortnight from England on the shores of the blue waters of the Pacific, without fatigue, where he can revel in a delicious climate, and in mountain scenery unrivalled for natural beauty and grandeur. The artist finds an untrodden and inexhaustible field of inspiration; the angler, excellent trout and salmon fishing in the numerous lakes and rivers that abound in the island and on the mainland; and the sportsman, his choice of grouse, prairie-chicken, duck, geese, swan, quail, deer, bear, elk, mountain sheep and goat.

The great improvement in the emigrant car is very noticeable, as compared with the Union Pacific of former days. It is constructed on the same plan as the first-class sleeping car, minus ornamentation, stuffed velvet seats, &c. The emigrant, with his mattress and pillow, can rest and sleep as soundly as his fellow traveller in the drawing-room car, and perform the journey in the same time and with the same ease.

In conclusion, I venture to say that the future of the Pacific slope is undoubtedly brilliant, and that British Columbia, the "England of the Pacific," will at no distant day be ranked among the foremost of Great Britain's possessions. Although not a great agricultural country, her valuable fisheries and forests, and her mines of coal, iron, gold, silver, and copper, offer an unlimited field for the employment of capital and abundant means for maintaining a large population.

DISCUSSION.

Mr. McLean thought this paper came very opportunely at the present time, when, from various causes, so much attention was being attracted to the Colonies. We had an overflowing population at home, the Colonies were becoming developed, and those in England wanted new fields for their enterprise and capital. He knew of no country which was so attractive as British Columbia, whether to the trader, the tourist, or the emigrant. Up to now the resources of the country had only been scratched; the vast forests, the teeming fish in its waters, and the gold and other minerals in its mountains, would form an attraction to capitalists and pioneers for many years to come. But the trader must undoubtedly go there chiefly as a pioneer—not for the purpose of taking part in existing industries, but of starting new ones. To the tourist the country offered unrivalled attractions—containing some of the grandest scenery in the world; and the facilities offered him were very great. The Canadian Pacific Railway gave return tickets from Quebec to Victoria for something like £20, but it would be an additional inducement if they could make arrangements with the other trans-continental lines, so that the return journey might be made by another route. On the coast there were abundant means for exploring the wonderful Archipelago, which extended from the Fuca Straits, right up to Alaska; there were the boats of the Hudson's Bay Company, a steamer which ran once a week from Victoria to the Skena river, and a service recently established from Takomar in Washington territory, right up to Alaska, of splendid steamers, with every modern convenience. The most important view, however, in which to look at British Columbia was as a field for our surplus population, and he was glad to hear what was said about the proposed arrangement between the English Government and that of British Columbia, on the subject of the emigration of the crofters. Having had an intimate knowledge of the crofters from his boyhood, he could say that there was no region so well suited for them as this. The country was very similar to their own, and that to an Highlander would be a great attraction. To take him to a prairie would be to leave him in a totally different environment from that to which he had been accustomed, but in British Columbia he could combine the cultivation of the land with the harvest of the sea. The coast line for about 400 miles abounded with fish, and it was not exposed to the storms which were so frequent in Scotland. The greater part of the fishing could be done in rowing boats, and there was almost constantly smooth water. But in dealing with this question it seemed to him that localities should be chosen by pioneers sent out by the crofters themselves, in whom they had full confidence. Let them go and find out the districts most suitable for those they represented, and then the crofters should go out in detachments, so as to form security for each other; where they would be able to form settlements which would become an attraction for the merchant, and furnish a market for some of the other products of the country. The great difficulty was the question of capital. These men could not transfer themselves 6,000 miles, half by sea and half by land, without capital. To meet the difficulty, he understood the Government had made an offer to the Special Commissioner from British Columbia to advance something like £100,000 at $3\frac{1}{8}$ per cent., provided the colony would guarantee both principal and interest. That seemed a fair proposal, but he did not know that it would be accepted, because he believed there was an idea that Canada and the Canadian Pacific Railway would derive great

benefit from the scheme, and that therefore the Dominion Government ought to aid in the matter. These were details, however, and he trusted some arrangement would be made whereby British Columbia would be able to attract settlers, and plant them where they could become thriving and prosperous citizens, and sources of wealth to the country, and at the same time a great bulwark to our own country on the shores of the Pacific. These Scotch crofters had always been to the front in the great battles of the British army and navy, and nothing could be better than to plant colonies of these men on the shores of our own dependencies.

Mr. J. H. COLLINS said he had just returned from British Columbia, and could corroborate a great deal of what had been said. He was in Yale on the 5th November, and saw wild strawberries ripe and fit to eat. He went specially to inquire into the mining resources of the country, and to that point he would confine himself. There was a great deal of rich alluvial soil in the neighbourhood of the Fraser River, but very little had yet been worked, and in fact, the main area of the country had not been at all explored; and the reasons were easily understood. In the first place it was an immense country, with a very small population, two-thirds of whom were gathered in five or six spots, and you might sometimes travel hundreds of miles without seeing a human habitation. Then, although the climate was good, it was not so suitable for exploring work as that of Arizona, Southern California, and New Mexico, where you could lie out in the open a great part of the year. In British Columbia there were sharp frosts in the winter and heavy rains occasionally, which made it difficult to get about. Then, the climate being humid, there was a thick coating of vegetation which hid the rock beneath, besides which, in many places there were thick beds of detrital deposits covering the solid rock. For these reasons vein mining had not yet made much progress, and such as had been done had not been very successful. It was on a very small scale to begin with, and what had been done had been carried on by men who knew nothing whatever about vein mining, they knew how to dig a pit, and how to wash gravels, but not how to work a vein when they came across one, nor how to treat the ore when they got it. The ore also of the upper portions of the veins was of a more refractory nature than further south, much less of it being free milling, and it required all the resources of the metallurgist to bring it into a profitable state. It could be done, but it required special skill and combined effort. But now British Columbia, instead of being far beyond the ken of almost everybody interested in mining, was within twelve or fourteen days of London; a man could go there and bring back an account of what he had seen, and many were doing so, and he had no doubt that in the next few years there would be a very large development of vein mining by means of British capital. It might be asked why the people already there did not engage in it. In the first place they had very little capital, and what they had could be invested in other ways to produce as good a return, and with less risk. English capitalists found mining pay, however, and before long no doubt they would engage largely in it. Right on the Rocky Mountains there was a large tract set apart by the Dominion Goverment as a national park, and at one end of this there were some very fine coal mines. One had three thick seams of what was called anthracite, and though it was not exactly that, it was of very good quality, and could be sold readily in San Francisco. A little further on there were highly promising regions where lead, some of it rich in silver and copper, had been discovered, and just over the summit of the Selkirks, at Illiecillewaet, there was a large mountain where, during last season, several veins were opened sufficient to show that it contained very rich ore. From three of those little mines 250 tons of ore were sent away to be smelted in the United States, and the average yield was nearly 100 ounces of silver per ton. There were other regions lying a little off the mainline, in the Nicola Valley, in the Similkameen district, and in Vancouver's Island, which would probably be opened this year, and the progress would be much more rapid if branch railways were constructed. There were also several promising mines in the Fraser River, and not only mines but benches of alluvial gravel on the sides of the Fraser Valley from 30 to 150 feet above the river bed. They were portions of the old beds of lakes formerly existing there, and every one contained gold, he believed, in paying quantities. They could not be worked by three or four men with a pick and a cradle, but if the appliances so well known in California for working large quantities of gravel were used, the gold from that valley would turn out to be many times in excess of all that had been got out up to the present. In every place he visited he had samples of ore brought to him, copper, lead, silver, gold, and iron, and in all cases the cry was that they did not know how to open the mines, or what to do with the ores. They had all to be sent away to the States to be smelted, and this swallowed up all the profit. The city of Victoria had offered a premium to the first person who erected smelting works there, and so had New Westminster and Vancouver. There was a good opening, therefore, but anyone who tried it must know something of the business. When railway contractors, storekeepers, and barbers started such enterprises, it was no wonder that they failed.

A MEMBER asked if any cinnabar was found there, because quicksilver was a very important element in the production of gold from the ore. He also asked if the average of life in Victoria was high or low.

Mr. BEETON said he was not aware of cinnabar having been found. The climate was very healthy,

but he did not think records of the mortality were available.

Mr. GRANVILLE SMITH said he had never seen this country, but he was connected with societies which were very much concerned with the welfare of our surplus population, and he thought it was impossible to combat the suffering of the poor unless emigration came to the rescue. A short time ago the question of colonisation was discussed in that room, and in another building he had heard Australia described much in the same terms as British Columbia had been, in order to attract the surplus population of British working men. But working men had of late set their faces against going abroad, and some other inducements needed to be offered if they wished to get out of the present difficulty, although it was not so great as was frequently stated. It required a very small surplus population to reduce wages; if five or even two men went to compete for work which was keeping 100 men employed at good wages, the whole 100 might soon find their wages reduced almost to starvation point. There were only two ways by which you could induce people to emigrate in greater numbers. You must either make it easier for them to go, or else provide some stimulus which would make them more desirous to go of their own accord. The first method looked to something in the way of an inducement offered by the Colonies to settlers. It was generally said that the colonist benefited three parties—the congested district from which he went; the home country, by providing a fresh customer for its markets; and the country where he settled, by the industry which he brought to it. There could not be much doubt that the third was the one most affected, and if that were so, that third party ought to make the greatest effort to attract emigrants. More ought to be done by the Colonies, not only with regard to the crofters, but to attract the working-classes. But if such small doings as affected the crofters of Lewis could be recommended as a starting-point from which much larger operations of land colonisation might be attempted, that would tend to attract the surplus population. He would not say much on the second subject, though he was inclined to believe that it would be found most efficacious. The motive of self-interest had hitherto been the one factor which had produced the Colonies of the British Empire. Only a hundred years ago people were discussing how our population could be induced to traverse the hemisphere in order to colonise South Australia, and all attempts were practically useless until gold was discovered. Those discoveries, by arousing men's cupidity, changed that which was almost a desert island into a land of boundless resources. If something of the same kind occurred in British Columbia it would solve the problem, and after what had been said already, he hoped that by the development of mining something would be done to attract the self-interest of our mining population. Hitherto the Colonial Government did not seem to have done all they could to make their mineral wealth known. The Rev. Denison Wood's geological description of the different territories of Australia and other similar reports were very widely circulated, and thus both capitalists and working men were induced to go there, and he would suggest that something in the same direction might be done by British Columbia.

Dr. EDMUNDS said he spent his last annual holiday in British Columbia, and had very fair opportunities of judging of the healthiness of the climate, and of the prospect of any man who was worth anything at all making a comfortable home for himself there. He had seen a good deal of Canada, but British Columbia took his fancy immensely, the journey over the Rocky Mountains and down the Pacific slope being one of the most magnificent to be found on the face of the earth. The climate was very different from that on the eastern slope; the width before reaching the ocean was much narrower, consequently the rivers ran more rapidly, and there were not the great level prairies to be found on the Atlantic side. The climate was mild, and very moderate in winter, quite a contrast to the extreme cold you get on the eastern slopes and in the prairie country. In fact, the temperature was very much like that of the British Islands. Nothing could be more beautiful than Vancouver's Island. The stores of timber were practically limitless, and there was abundance of game. The English pheasant was introduced there six or eight years ago, and none were allowed to be killed until last year, by which time they had increased enormously. In the Nanaimo mines the amount of coal was limitless; all that was required was labour, labour of an honest character, not that which went there merely to speculate, or enticed by gold mining, but men who would settle down in earnest, grow up with the country, and take their share of the wealth which they produced. Nothing he had seen or read of equalled the marvellous growth of the city of Vancouver. As he sat there at breakfast, facing Burrard's Inlet, and looked over the glorious panorama of three miles wide, with a grand land-locked bay twenty miles in length, deep enough for all orders of shipping, with an inlet of not more than one-third of a mile in width, through which the ocean flowed out of the Straits of Georgia, he was charmed with it. And that peninsula only about a year ago was an almost pathless forest—with trees some of them as big as a railway train. He measured one which was 180 feet to the first branch, and six or eight feet in diameter. They had been cut down and the whole district cleared within about twelve months, the trees being burned to get rid of them. On that magnificent site a great city was now growing up, miles of splendid roads, with fine solid stores, hotels, and villa residences already built as if by magic, and he did not know any place where, if he were a young man, and capable of carrying on

any business or starting a small store, he would sooner go to. There was an enormous territory of fertile land, the fish were limitless in number; salmon were actually being swept up out of the water into the boats; and the whole country was capable of anything; the only requisite was an industrious population. The more one looked into the question of emigration the the more difficult it was. He had never found any man who was good for anything who could not get a living in England; any man could get a good living here who knew what he was about, was thrifty, and worked hard. But if you took that sort of man to Canada or British Columbia he would get on much faster, and would go farther. He would soon become his own master, and if he invested his money in land, the unearned increment would be sure to make him a comparatively rich man. The moment you came to the question of forced emigration the difficulty was how to view the question. Was England to be the breeding ground on which large numbers of people were to be reared, of which all the best were to be shipped off to the Colonies at the expense of taxes raised from the remainder? In that way all the old countries would retain the residuum; only the best would go to the Colonies, and we should be at the expense. Until very lately Canada had not made the preparation it was worth its while to do for the reception of emigrants. A man going out there would have about half a square mile of land given him, but it would take him about eighteen months before he got any return from it, and meanwhile his little capital was melting away. A large number of well-meaning and capable emigrants wasted their first summer in looking about for a particularly good plot of land, instead of settling down at once on some fairly good piece where they would be pretty sure to do well; then they wasted their money by getting into the hands of people who fleeced them in the sale of implements and things of that kind, and in that way many of them were disappointed, by mere accident and from want of proper arrangements being made for their reception. The Manitoba and North-Western Railway had been laying out plots for emigrants, and building little houses upon them, so that a man going out in the summer might find some of his ground sown and be set to work at once. Those men were doing splendidly, and they would each form a centre and an advertisement for the district being peopled by that railway. The population of England is increasing at the rate of 1,000 a day, and it was perfectly clear that we were not able to provide food for all these mouths, and could only live as a centre of trade, in the words of John Bright, by serving as the workshop of the world. It seemed to him that the State had a great duty in this matter. Just as the father of a family felt it his duty to launch his children in the world, so it was the duty of the country to combine with its Colonies, in order to see that its people should be taken out and set down under circumstances which would practically ensure their doing well. There was as much aggregation of people in the colonial cities, and as much misery, as in London, and it was people falling into these places and going to the bad which brought undeserved discredit on emigration schemes.

Mr. NEAL said he had lately been to the northern portions of the coast of British Columbia towards Alaska, where there was abundance of fish, and he found the fishing industry much expanded. The difficulty the crofters would find in going there would be the distance from any market, and he did not think they would be able to do much except in the canning of salmon. In some parts fishing might be combined with agriculture, but on the mainland the country was covered with impenetrable forests, and he thought before long the timber industry would be one of the most flourishing in the country.

The CHAIRMAN said this paper was not only interesting in itself, but had been the means of eliciting a most valuable discussion, dealing with some of the questions which lay at the very root of the matter, and which were felt by both the old country and the new. It was only by such discussions that the real difficulties could be adequately brought out, and means suggested for overcoming them. He proposed a hearty vote of thanks to Mr. Beeton for his paper.

The vote of thanks having been carried unanimously,

Mr. BEETON, in responding, said it was a very serious matter to stimulate emigration on the ground of gold discoveries, but he sympathised with Mr. Smith's remarks to a certain extent. Gold was, of all things, the most attractive to the people of old countries, and the country which was fortunate enough to possess gold was sure to attract a large population. They were quite alive to the importance of this matter in British Columbia, but desired to act cautiously. He believed they were on the eve of a very important development of quartz mining, but it would be wrong to be over sanguine. When it was once demonstrated, as he held it soon would be, that they had paying quartz mines, there would be no difficulty in getting both labour and capital. Quartz mining was a perfectly legitimate industry, and one of which any country might be proud. He was in hopes it would soon be established in British Columbia, and when this was done, there could be no doubt that other industries would soon follow.

Mr. HYDE CLARKE writes:—While I listened to the exact statement of the writer of the paper as to the present prosperity of British Columbia, and the wonderful career that is now beginning for it, I could not but reflect on the intimate connection of this

subject with our whole colonial policy. British Columbia is a new name, unknown in history, but it is the outcome of old, and what ought to be familiar, history. In this time of Jubilee, Queen Victoria enters on the greatness of inheritance of Queen of Albion, in the World of Gold, conferred on Queen Elizabeth by Francis Drake. On December 13th, 1577, Drake left Plymouth on that voyage round the world famous for so many things which do not now concern us. In pushing into the North Pacific he made those discoveries, under the name of New Albion, of which the English speaking races now hold possession. The June and July of 1579 he spent there, hoisting the red cross of St. George, and taking formal possession for Elizabeth. Drake ranged between 38° and 41°, and the place where he landed is within the bounds of the present State of California. The party that went inland made such statements as to the surface deposits of gold and silver, that for two hundred years they were regarded as fabulous. The famous Candish or Cavendish followed Drake in 1587. They considered they had secured for England a route to China, which in the development of prophecy proved to be true. In the last century Cook followed them to these coasts, and his discoveries and claims were accepted as appendages to those of Drake. In our great hall to the right of the Chairman, Barry has depicted Drake and Cook secuiing for Britannia the triumphs of Ocean. Cook's station of Nootka Sound became a definite point for the renewal of our relations with the coast. His narrations produced great influence in the last century, and in the early stage of this Society. The Government maintained the national claims to the north-west coast. The voyages of Vancouver, Pattock, Dixon, and Meares awakened public attention at home, and the jealousy of the Spaniards. The settlement of Captain Meares at Nootka, on Vancouver Island, and the English ships were arbitrarily seized by the Spaniards. Then William Pitt intervened, and his action was the turning point in the restoration of English power in Europe crippled by the American war, and the loss of the thirteen provinces. He resolved to defend our rights in the Pacific, and one of his great feats was his resistance to the Spaniards, and compelling them to withdraw. A compromise was made, whereby English claims with respect to Spain were more strongly defined. The subsequent history of the subject, the transference of Spanish claims to the United States, and the compromise with the United States, are more familiar. It is, nevertheless, the fact that the wishes and plans of our predecessors have been accomplished, and New Albion, and the route to China and Japan, are in the possession of the English-speaking race. We hold 375,000 square miles in British Columbia and the United States; as much in the three States of California, Oregon, and Washington, constituting another tie of union between us. It may be this year —when the three hundredth anniversary of the victory over the Armada is celebrated here—that it and the name of Drake may be commemorated at Vancouver and Victoria, as at San Francisco. British Columbia has the proud title of being one portion of New Albion, and of an historical connection with the mother country of three hundred years.

INDIAN SECTION.

Friday, February 10, 1888; J. M. MACLEAN, M.P., in the chair.

The paper read was—

THE WORK OF THE AFGHAN FRONTIER COMMISSION.

By CAPTAIN MANIFOLD, R.A.

I must apologise to you for being in the position of reader of this paper, when there are present men who have taken a leading part in the demarcation of the Afghan frontier, and who are consequently in a position to deal with this subject in a much more accurate and thorough manner than I can; but, unfortunately for the gratification of public curiosity, absolute reticence has been imposed on these officers by the authorities, and there is no probability of their soon being able to give us their valuable experience and opinions with regard to the new frontier. Rather than see a matter which is of such great national importance allowed to pass by unnoticed, I have offered myself as their substitute, and ventured to take up the subject this evening.

Since the time of Peter the Great, Russia has been extending her empire steadily and surely eastwards, and towards the Indian frontier, but until the last twenty years, our boundaries have been so far apart that we need not consider any diplomatic action which has been taken; but in the years 1864-68, the conquests of Russia began to follow very closely one upon the other—these included the taking of Tashkent by General Tchernaieff, in 1865, and culminated with the capture of Samarkand in 1868, and the complete destruction of the military power of Bokhara. It was at this time that the Liberal Government then in office first took steps, in obedience to what Mr. Gladstone styled "a natural but inconvenient susceptibility on the part of the public" to bring before the Russian Government the dangers which a further advance in the direction of India might entail to the good

relations subsisting between England and Russia. The result of these negociations was the expression of a desire on our part to place the demarcation of the Russian boundaries in Asia on some definite basis; but in reply to a letter from Lord Clarendon, in 1869, suggesting that a neutral zone should be defined between the two empires, Russia proposed that the "kingdom of Afghanistan" should be the zone, but this was met by an emphatic negative by our Foreign Secretary, who stated that such an arrangement would give Russia too much power in enabling her to approach India from the Turkoman country, *i.e.*, from Merv, although this name is not actually mentioned. After this distinct expression of opinion on the part of our Government, Russia evaded further reference to this matter, but at the time of the Khivan expedition, thinking such a step advisable for the furthering of her interests, she gave us every assurance we could wish for.

In 1869, Prince Gortchakoff assured our representative that Samarkand would be restored to the Amir of Bokhara, and in November of the same year he said "that there could be no objection to the English officers going to Cabul, but that Russian officers should not do so." The results of these promises have been shown by the occupation of Khokand and the visit of the Russians to Cabul in 1878.

In 1872, the rumours of the Khivan expedition again called for a remonstrance, and Lord Augustus Loftus drew the attention of the Russian Government to the fact that Shere Ali's dominions included both Badakshan and Wakhan. The nearness of the Khivan expedition induced Prince Gortchakoff to waive Russia's claims to these states, a matter which should be of considerable importance in the future, and our Government, aware of the outrages committed by the Khivans, gave its sanction for the expedition, on the assurance that "as soon as the object of the expedition was attained, the troops would be withdrawn from the Khanate." But before 1873 was ended it was known that Russia had, by employing an overpowering force, completely conquered Khiva, and was determined to retain the greater part of its conquest.

This breach of faith called forth a despatch from Lord Granville, dated January 7, 1874, in which he drew attention to "the fears expressed by the Amir of Afghanistan as to the complications in which he might become involved with Russia, were the result of a Russian expedition against Merv to be to drive the Turkomans to take refuge in the province of Badghis." The whole document went on to show the dangers which even an advance "into the vicinity" of Merv—which would force the Turkomans to take refuge in Afghan territory—would cause. In reply to this despatch, Prince Gortchakoff "repeated the assurances he had always given, that the Imperial Government had no intention of sending any expedition against the Turkomans, or of occupying Merv."

The Conservative Government of 1874 followed the same indefinite line of policy as their predecessors with regard to the Russian advance on Merv, while the protestations of Russia were no less emphatic. On the 19th of April, 1875, Prince Gortchakoff wrote:—"His Majesty has no intention of extending the frontiers of Russia from such as they exist at present in Central Asia, either on the side of Bokhara, or on the side of Krasnovodsk and of the Atrek. We have no inducement to do so." Notwithstanding these expressions of official opinion on either side, General Lomakine's operations still continued, and on June 13, 1877, Lord Derby again strongly protested, in a despatch, which was replied to by Count Schouvaloff, who said that "the sole object of the expedition to Kizil Arvat is to punish the Turkoman hordes, who have for some time infested the road from Krasnovodsk to Khiva. These tribes belong to a branch of Turkomans quite distinct from that of the Tekkes of Merv, a point 1,000 versts distant from Krasnovodsk."

Although Mr. Gladstone's Government had been the first to point out the importance of Merv, the same policy of indifference was maintained, and Russia still moved forward, defeating the Turkomans at Geok Tepe in 1881, and occupying Merv in February, 1884, although after the formation of the Askabad district she had disclaimed all intention of any further advance. Matters had now reached such a pitch that it was considered imperative to meet the Russian seizure of that place by a demarcation of the Afghan frontier, and on the 29th February, 1884, our Foreign Secretary asked the Russian Government what it proposed doing, now that its frontiers were in immediate contact with Afghanistan, and Sir Edward Thornton brought to the notice of the Russian Government a Russian military map, in which the Afghan frontier was placed south of Panjdeh and Pul-i-Khatun, and which was at complete variance with all our maps, but

the Russian Minister disclaimed any official authority for this map.

On the 29th of April, 1884, Lord Granville wrote on the subject of a joint commission, that, "her Majesty's Government are prepared to accept the proposals put forward in 1882, and now repeated by M. Giers for the delimitation of the frontier from Khoja Saleh westwards." To this the Russian Foreign Minister replied somewhat dubiously, making reference to various ethnographical considerations. However, matters were so far agreed on that it was ultimately settled that two Commissioners, one from each Government, should meet at Sarakhs on the 1st October, 1884. The Viceroy of India (Lord Dufferin) had proposed that the Amir should have a representative, but owing to opposition from the Russians the point was not pressed.

Sir Peter Lumsden, who was the Commissioner appointed by us under the original agreement, left London on September 4th, and every information as to his nomination and the strength of the escort which would join him from India was explicitly explained to the Russian Government. When Sir Peter Lumsden arrived at Tiflis he met General Zelenoy; the latter, however, had to return to St. Petersburg for instructions, and then, owing to his illness, the meeting of the Commission was delayed. The force which left India consisted of 200 of the 11th Bengal Lancers, under Major Bax, and 250 of the 20th Punjab Infantry, under Major Meiklejohn, and the various members of the Quartermaster-General's Department, Survey and Foreign Office, which, together with hospital corps, camel drivers, and transport followers, made up a total of about 1,300 men. This force moved from Quetta to the Helmund, *viâ* Nushki, crossing over 200 miles of unexplored desert to the Helmund. Water had to be carried, although the excellent arrangements made by Captain (now Colonel) Maitland proved that the supply was much better than had been anticipated, and that by sinking wells a fair supply could be obtained, a point of very great importance in considering the military routes to India. From the Helmund to Herat there was another stretch of 550 miles of unknown country. Some of the marches were long and trying; 38 miles in a day to be performed by 500 men, 700 followers, and 1,800 camels, is a fine performance, considering, too, that for the previous six weeks marches had averaged from 16 to 17 miles. Such a good spirit existed in the 20th Punjab Infantry that they declined to avail themselves of the help of the camels which had been provided for the conveyance of the followers. From Herat this force had to move through the district inhabited by the Aimak tribes to Bala Murghab, near Panjdeh. The country is mountainous and difficult, the total distance from Quetta being 1,100 miles, the average of the marches, including halts, being at the rate of 14 miles a day.

While waiting for the Russian Commissioner, Sir Peter Lumsden employed his time to great advantage in surveying the region between the Heri Rud and the Murghab, in collecting information as to the tribes inhabiting Badghis, and the neighbourhood, and in ascertaining facts as to the claims of the Turkomans and other people in the districts, likely to come under dispute. During this time the Russians continued massing large forces on the Murghab, a movement which culminated in General Komaroff's attack on the Afghan position at Ak Tepe on March 30th, 1885. With regard to this now memorable, though much to be regretted, engagement, I will quote from General Komaroff's official report, and Sir Peter Lumsden's remarks on the same. General Komaroff says that "on the 28th the Afghans occupied a height which commanded the left flank of our camp; they began to throw up entrenchments there, to establish a post of cavalry behind our line, and placed a picket at gunshot distance from our ford." To this Sir Peter Lumsden replies, "that the Afghan Commander did, on the 28th, after the hostile reconnaissance of the 27th, place a post of observation on the hills on the right bank of the Murghab, but this post was withdrawn the next day." General Komaroff states that he sent the Afghan Commander an energetic summons, and that he also addressed a private letter, written in friendly terms. Sir Peter Lumsden replied to this that the letter in question was never seen by any officers of the Commission. General Komaroff again states: "On the 30th, to support my demands, I marched with my detachment against the Afghan position, counting on a pacific result, but artillery fire, and a cavalry attack, compelled me to accept combat." To this Sir Peter Lumsden answered: "The Russians advanced to attack the Afghan position, and, of course, the Afghans were obliged to defend themselves."

There is not time to go further into a detailed account of this engagement, but there can be very little doubt as to the aggressive

action and desire to provoke a collision on the part of the Russians, which, considering the tension between both parties, was bound to produce a fight. The Afghans could not withdraw from the left bank of the Kushk. Had the General given such an order, he would have been at once suspected of treachery, and such a withdrawal would have been a signal for a rising among the Sariks. The battle lasted an hour, but in this short time the Afghan loss amounted to at least 500 men. The difficulties experienced by the British party in withdrawing from Panjdeh to Gulran were very trying, the Kushk was in flood and could not be crossed, and so all the party had to spend the night on the banks of the river, without shelter from the heavy rain; all through this trying time the headmen of the Sariks behaved most staunchly, and prevented all pillaging, although many of their people were hanging about waiting for an opportunity to begin as soon as Captain Yate departed.

On the 9th May, 1885, Sir Peter Lnmsden left Tirpul, an order from the Home Government having directed him to return, to give information with regard to the Panjdeh incident. After his departure, the charge of the Commission devolved on Sir West Ridgeway, and the head-quarters moved for the summer, at first to Camp Surjan, and afterwards to Khush Rabat. Very few of the members remained, however, in camp; survey, intelligence, and political work calling them to places far distant.

This preliminary sketch of the chief diplomatic phases of the Anglo-Russian question, and of the earlier passages in the history of the Commission itself, which I have made as short as possible, is necessary for a correct appreciation of the work done by, and the general results of, the Commission.

The length of the new boundary may be taken at about 350 miles. According to the report furnished by Sir West Ridgeway to the Marquis of Salisbury, the frontier begins on the right bank of the Heri Rud, at a point marked on the map by pillar No. 1, situated about 3,000 yards distant from a small tower, at the mouth of the Zulfikar Pass. The frontier runs easterly for nine miles, then it descends in a south-easterly direction to pillar No. 8. From pillar No. 12 the line turns eastwards to pillar No. 17, which is about thirty miles east of Ak Robat, and again to the south-east to pillar No. 19, which is three miles south of the springs of Islim.

From here the boundary line was drawn to Chaman-i-Bed, where it crossed the Kushk, and on to a point now known as pillar No. 35, which is on the Murghab, 15 miles above Maruchak, the barren lands between the Kushk and Murghab being thus left in the hands of the Afghans.

When the joint Commission arrived on the ground, it was discovered that the Sariks, who were supposed to only inhabit the main valley of the Murghab, had extended into the side valleys of the Kashan and Kushk, and had been accustomed to use the ground between the Kushk and Murghab as grazing lands. Now, by the London Protocol of September 10, 1885, Panjdeh was ceded to Russia, and with it the Sarik Turkomans who inhabited that place; consequently, the Russians considered that the smaller valleys should have been given to them together with the larger, and contended that if this was not done there would be a very great flaw in the treaty, as it was only a want of accurate geographical knowledge, and of tribal rights, which had made such a mistake possible. About the same time the dispute arose as to whether the frontier should be drawn from Dukchi to the Oxus at Kham-i-ab or to the Ziarat-i-Kwoja Saleh, 17 miles up the river. Under these circumstances, the only solution could be found in a compromise, and the frontier in the western portion of the zone of delimilation was moved more southwards, so as to give to the Sariks their pasture lands between the Kushk and Murghab. The new frontier by this arrange-ran from pillar No. 19 in a south-easterly direction, to pillar 22, a short distance north of Kara Tepe, thence it ascends the River Kushk to pillar 23, which is north of Chihil Dukteran; from this point it works in a north-easterly direction, keeping by no means a straight line, to pillar No. 29 to the north of Tora Shehk, where the boundary crosses the Kashan, and from there turns more to the north to pillar No. 35, half way between Maruchak and Bala Murghab. From this point up to pillar No. 65, the frontier, as I previously said, was fully demarcated in 1885. From pillar No. 35 the frontier descends the Murghab to a point three miles north of Maruchak, which place is left to Afghanistan; thence it turns somewhat eastward, and again in a north-easterly direction, to pillar No. 50, which is about 30 miles due north of Mamana; pillar No. 64 is fifteen miles to the west of Daulatabad. The frontier now keeps due north through a number of low sand hills, leaving Andkhui about 20 miles to the east,

and at pillar No. 60 it reaches Chichli, where there are a number of dry wells; from this point it turns eastward to pillar 65, which is just south of Dukchi. From here to the Oxus the demarcation was left over for future settlement, the Commissioners being unable to agree whether the frontier should pass to Kham-i-ab or to Khoja Saleh, 17 miles higher up the Oxus. The Russians claimed that by the treaty of 1873 the Afghans had no rights to any lands below the shrine of Khojah Saleh, and were territory below this place conceded, then the rights of Bokhara would be seriously infringed. The Imperial Government also considered it still less possible to sacrifice these rights since, in consequence of the demarcation carried out in accordance with the London Protocol of September 10, 1885, the Sarik Turkomans had been dispossessed of the land they had previously held, and these lands given over to Afghanistan. On account of this disagreement, the joint Commissioners were recalled, and negociations transferred to Europe. Sir West Ridgeway was directed to propose a frontier which, starting from Dukchi, would terminate at Islim, a few miles below the shrine of Khoja Saleh. The Imperial Cabinet of Russia would not accept this proposal, maintaining that Khoja Saleh was the name specified in the treaty, and that consequently that point should be considered as the extreme Afghan boundary on the Oxus. Our Government considered that such a demarcation would entail considerable inconvenience, as the canals used for irrigation below Khaja Saleh take their rise in the neighbourhood of Kilif, a circumstance which could not fail to be a source of continual dispute. To obviate this difficulty, Sir West Ridgeway, who had proceeded to St. Petersburgh in May of last year, was authorised to offer the Imperial Government in exchange for the territory claimed on the left bank of the Oxus, the territory of which, as already explained, the Sarik Turkomans had been dispossessed, in consequence of the tracing of the frontier line in conformity with the provisions of September 10th, 1885. This proposal was agreed to by the Russian Government, and the frontier traced through point B, at Kara Tapa Khurd, through what is known as point C, to the wells of Ali Kadim, these latter falling outside the Afghan boundary, and from this point, in a straight line as far as the commencement of the local frontier between Bosagha and Kham-i-ab, the inhabitants of Bosagha having exclusive rights over the control of the waters of the canal supplying their territory, and thus the labours of Sir West Ridgeway and the Commission were brought to an end, and the treaty duly signed on July 22nd, 1887.

With regard to the cession of territory in the valley of the Kushk and Kashan, we see that if literal effect had been given to the agreement of 1873, then the district of Kham-i-ab, and nearly the whole of the Khoja Saleh district would have been severed from Afghanistan. It was from a consideration of these facts that Sir West Ridgeway was authorised to negociate a settlement by which the Amir should restore to the Sariks the lands of which they had been deprived between the Kushk and the Murghab, in exchange for the withdrawal of the Russian claims to all the districts in Afghan posssession on the Oxus.

The Afghans by this arrangement conceded 100 square miles of territory more than they received, but as the lands they received had a population of 13,000 persons, with a revenue of £1,400 per annum, while the district conceded is almost an unpopulated waste, the gain is decidedly with Afghanistan.

The frontier, on the other hand, is brought 11½ miles nearer to Herat—*i.e.*, it is now about 75 miles from that city. There were no Russian outposts on the former frontier, and probably there will be none on the new frontier, as Russian troops have been withdrawn from Panjdeh and transferred to the Oxus, in the direction of Khoja Saleh; in fact, the movement of Russian troops has been eastward, a point which gives increased importance to our gain of knowledge relative to the northern passes of Afghanistan.

In the district ceded to the Sariks Russia claimed the lands which she said belonged to her subjects, but Kara Tepe, Chihil Dukteran, and Torsekh, the only possible sites for a cantonment within the lands once occupied by the Sariks, have been left to Afghanistan. The disputed claims are most clearly summed up in Sir West Ridgeway's article in the *Nineteenth Century* for October last. In it he says:—"We claimed lands for the Afghans which had never been occupied by them, and which were in the possession of the Turkomans of Panjdeh, and we based our claim on the letter of the London Protocol of 1885. Russia, on the other hand, claimed for Bokhara lands on the Oxus which had long belonged to Afghanistan, and she based her stand on the letter of the Treaty of 1873. Surely if ever

there was a case for compromise for give and take, it was this." This, then, is the Afghan frontier, and we see that, putting aside Panjdeh, the Amir has not lost revenue, subjects, or any lands ever inhabited by his subjects.

With regard to the district and country in the neighbourhood of which the frontier passes, we will first consider Herat, for although the frontier is far north of it, still it has always attracted much more attention to itself than any other part of Afghanistan, and it should consequently not be left unnoticed.

On the march from Quetta to Bala Murghab, the Indian division did not actually visit the city of Herat, the nearest point to it at which they encamped being distant about 30 miles. It was then thought possible that the Governor of Herat would consent to a party visiting the city, but owing to the rumoured unfriendliness of the troops, he did not consider it advisable; later on it was visited by Colonel Holdich, Major Peacocke, and Major Gore, of the Royal Engineers, who gave the Afghans valuable advice as to measures for the improvement of the fortifications, the execution of which arrangements they themselves supervised, so that the city is now secure from being taken by a *coup de main*. This is not the place to enter into the details of the fortifications; the guns we gave to the Amir in 1885 have now been mounted, and were it not that the city can be commanded on one side, and has other weak points which our officers discovered, it could offer a lengthy resistance, but even as it is, a regular siege would be necessary for its capture. The duration of this resistance will, of course, greatly depend on the besieged themselves, whether they are determined to fight with stubbornness, or merely inclined to be passively obstructive; and treachery, a danger most to be feared by the Amir, must also be taken into account. The state of the roads would have great effect in case of a siege, as on their condition would depend the class of guns which could be brought up for a siege.

The productive power of the Herat valley has been, according to the latest reports, much over-rated. The population of the city is, at the outside, 12,000, and it is probably less, while that of the entire valley, which is some 40 miles long by 20 miles broad, does not exceed 50,000.

The valley is surrounded by barren hills; on either side of the river strips of land are cultivated, and in the present state of cultivation, not more than 20,000 or 30,000 men could be supported by the produce of the Herat and Ghorian valleys; the yield of the soil too is small.

The approaches to Herat are now known to be very easy, and those reports which we once heard of impassable mountains to the north, are now known to be the reverse of true. Major Peacocke has told me that there are a succession of half a dozen easy passes, such as the Khombau, Chesma Sabz, Ardewan, &c., across which a coach road could be easily made, so that any shortcomings in supplies arising from diminished cultivation in the valley itself could easily be made up by transporting them from the Caspian-Samarkand Railway, *viâ* Mashed on the west, and the Kushk and Heri Rud valleys on the north. From our side of the question, the opening of our railway to Quetta, and beyond to the Khojah Amran range, has strengthened our position very considerably. Supplies can now be collected without difficulty at our base, and an advance rapidly made to the Helmund or Kandahar.

Crossing the range to the north of the Herat valley, Badghis is reached. It is naturally a fertile country, as it is well watered by springs and streams, which gradually lose themselves in the desert through which the frontier line runs. The country must have been formerly well populated, but the raids of the Turkomans have completely devastated it.

The greater portion of the country through which the new boundary runs is a wilderness, except where the Heri Rud, the Kushk, the Kashan, Murghab, and Oxus traverse it; along all these rivers there is cultivation. The valley of the Kushk is well cultivated; wheat, barley, and melons are grown; the hills are fairly well covered with grass; on these many sheep graze, but water is very scarce. Imported articles come almost wholly from Russia, while English goods are but little seen—a most serious matter from a commercial point of view. Sugar comes largely from Russia, also cloth. In the neighbourhood of Kushk are many saline and chalybeate springs, so much so, that Captain Yate says that one day the place will probably become a fashionable spa. This is the district we have handed over to the Sariks. These people are well-to-do; flocks, herds, numdahs, and carpets represent their principal wealth. They also manufacture warm cloth; many of our men were clothed in this material while with

the Commission. This tribe are not such inveterate robbers as the Tekkes.

The boundary next crosses the Kashan Stream; in winter this stream holds a good deal of water, but in summer it dries up, the hills in the district are covered with the pistachio nut, the yield from which is very considerable. On the upper part of the Kashan are many Hazara and Jamshidi villages. These people store their forage and grain for winter use in pits, and much in the way of ensilage might be learnt from them. The boundary line next passes into the Valley of the Murghab, and skirts close to Bala Murghab, which has been left in Afghan possession. It was here that the Boundary Commission spent the winter of 1884-85, while waiting for the Russian representatives to join them. The citadel has been lately rebuilt, it is entirely made of mud, and the walls would not stand artillery fire for long. The land on either side of the Murghab is almost entirely under cultivation for a distance of one and a half miles to two miles. East of the river the settlements are chiefly those of the Firizkuhis, while west of it are the Jamshidis, with a sprinkling of Hazaras. Judging from the bags made by members of the Commission, game both small and large must be very plentiful; twenty-four head of ibex and oorial in two days is enormous, while pheasant, snipe, and wildfowl abound. The weather was very trying during the winter, 30° of frost being frequently registered, and this in a tent was very severe. While at Bala Murghab a present of postins was sent by the Amir to the officers of the Commission. Unfortunately, the number of fur coats was less than the number of officers, so the recipients had to be chosen by lot, and the drawers of blanks to remain satisfied with their old coats, while they saw their more fortunate companions decked in the Amir's gay gifts.

The country between the Murghab and the Oxus much resembles Badghis, the rivers which descend from the Hindu Kush losing themselves in the Chul. The Chul is the name given to the undulating hills and downs that extend from the slopes of the Tirband-i-Turkistan mountains to the edge of the sandy tract that lies between Merv and the Oxus at Khaki. The settlements on the Murghab, viz., Maruchak, Panjdeh, and Yulatan are connected with Andkhui by direct routes across this Chul. There are wells along this route, but the water is generally foul from want of attention, but with a much decreased population these routes are now little used. To lose one's way on the Chul means loss of life; in the spring and early summer the supply of grass is most abundant and excellent, but it soon withers, and then animals as well as man must find the journey trying and difficult. A man may carry sufficient water for himself, but to carry water for a horse is an impossibility, consequently, if the line of wells is once lost, death from thirst is almost a certainty. In winter these difficulties are much increased, for then the snow lies deep, and all tracks are obliterated, the greatest care has therefore to be taken in observing the few landmarks which are quite unapparent to the untrained eye, but the Turkoman guides can recognise them and show the roads with marvellous accuracy. Mr. Ney Elias, who has had great experience in travelling through desert lands, told me that the Turkoman guides of the Chul showed a marvellous instinct in their power of guidance across these wastes, which could hardly be equalled in any part of the world.

The Ersari Turkomans, the Uzbeks, and the inhabitants of Andkhui and Maimena, graze their flocks in the Chul, south of the frontier line, and between Maruchak and Andkhui. The frontier passes a little to the west of Andkhui. The population of this town and the neighbourhood are principally Uzbeks, together with a few Turkomans, Jews, and Hindus. From Andkhui to the Oxus, a distance of sixty miles, the road again becomes a sandy desert. For the first thirteen miles there is the Chul, with its plentiful supply of grass in certain seasons; but from this to the Oxus is a long stretch of desert drift sand, which at Kilif is only twenty miles wide, but increases steadily in width as it extends westward. Close to Kham-i-ab is a fort once used as an Afghan convict station. From Kilif through Khoja Saleh to Kherki is a distance of seventy miles, and the bed of the Oxus is very wide all along, while between September and April great mud flats are found, but these disappear when the river is in flood. Ersari Turkomans are settled on both banks; some of these live in kibitkas and some in mud houses. The kibitka is a tent made of felt, supported on a framework of lattice-work; they are extremely warm, and when spread with carpets can be made most comfortable. The Ersaris cultivate silk-worms, the mulberry trees for their nutriment being grown on the banks of the canals. The raw silk is exported to Bokhara, and there worked into those very

gay silks which are largely brought to India. The Erasis also manufacture carpets.

Lower down the river dwell the Kara Turkomans, who have still the name of being raiders, but their trade has now become almost a thing of the past. Thirty-five miles above Kham-i-ab is the Kilif ferry; it is on the main caravan route between Bokhara and Balkh, Mazar-i-Sharif, and all the important towns of Afghan, Turkestan, and Badakshan. The place much resembles Attock on the Indus, as the Oxus is here gathered into a single stream 350 yards wide, shut in by high cliffs. The ferry boats are towed across by a single horse, guided by a bridle from the boat.

Turning back to the general results of the Commission we see a most marked improvement, which it has effected in the relations between us and the Afghan people. In September, 1879, Sir Louis Cavagnari and his escort were massacred in Kabul, and after that it was considered unadvisable for us to have an English representative there, all our diplomatic work being carried out through natives; again, in 1884, the portion of the Afghan Commission, proceeding from India, were unable to march through Afghanistan direct, but were obliged to make a detour to avoid Kandahar and Herat; since then we see a marked change, the Commission returning through the heart of Afghanistan, *viâ* Bamian and Kabul, where they were fêted and honoured in every way, and thence to India by way of the Khaiber Pass. Individual Englishmen may now go in safety to Kabul. Mr. Pyne has been living there for some time as director of certain of the Amir's factories, while Captain Griesbach, of geological fame, is shortly going to Kabul, to examine and report on the mines in the neighbourhood. Last August Mr. O'Meara, the dentist of Northern India, was specially summoned to attend the Amir; he went to Kabul thinking that his chance of return was small, but instead of meeting with danger or unpleasantness, every honour and distinction was shown to him.

British officers may now, with the permission of the ruler, live and travel in safety in Afghanistan. Abdur Rahman is himself well disposed towards the British Government. His confidence in the stability of our rule is shown by the way in which he has recently been purchasing house property in Peshawur, and besides the large money aid of £120,000 per annum which he receives from us as a subsidy, the care and trouble with which the frontier has been demarcated must confirm his belief in our pledges. In every question connected with the demarcation of the frontier his wishes were consulted, and, contrary to the supposition that pressure was brought to bear to induce him to give up Panjdeh, the case is quite the reverse, for when he saw that the Czar had, by more able diplomacy and other means, established a kind of claim to the place, considering it not worth fighting for, he let it go; in the same way he knew that the Sarik Turkomans disliked the Afghan rule, and consequently he yielded to the cession of their settlements and grazing lands on the Kushk and Kashan.

We are not only on better terms than ever with the ruler, our relations with the Afghan people are vastly improved. The actual passage of the Commission through Afghan territory effected this. Supplies of all kinds and transport animals were largely required, and these have been promptly paid for in hard cash. The effect of the £300,000 spent in this way has been very great, and has, I consider, done us more good than many years of diplomacy had been able to accomplish. To be paid for work done for the State is a new and pleasant experience in Afghanistan, where enforced State labour is the custom. Camel owners and contractors would now only be too pleased to come forward and hire out camels or any baggage animal they may have, the receipt of £3 a month for the camels hired out for Commission work having effected this; and the regular payments made have produced confidence and a liking for us which can be easily understood.

The people of Afghanistan would now be disposed to welcome our return; they understand us much better than formerly, though they may still have a national mistrust of our Government, which has been engendered through long years of an unsettled policy. In crossing the Hindu Kush we have come into political contact with Turkomans and Uzbeks for the first time. Before the Commission visited Afghan Turkistan, our acquaintance with these people was very scanty; now we clearly know the relations which exist between them and the Russians and the Afghans, and we have left a popular name behind us. Much information—both military and scientific—has also been gained. The work done by Colonel Maitland, and others connected with the Intelligence Branch, has been of great value. Colonel Maitland and Major Talbot travelled, in 1885, from Herat, through Obeh and Dau-

latsar, to Bamian. The first marches lay up the Heri Rud river, just beyond Obeh. Sirdar Ibrahim Khan was met with on his way from Kabul to join the Mission; he gave an excellent account of the road. He had been 16 days coming from Kabul, but had there not been delay, owing to his baggage-animals breaking down, he had meant to have reached Herat in 12 days, which would have given an average of over 40 miles a day. This alone proves the quality of this road, which we now know to be largely used for military purposes, large convoys continually travelling by it when conveying stores to the Herat Arsenal. The Hazaras are considered to be a simple, good-natured, and industrious people, easily managed, but of no value as fighting material. Under the present Amir, the Hazarajat has been much opened up, and an excellent military road is being made from Kabul to Kandahar; this road will be quite practicable for guns, though in places it would require re-metalling, and the gradients lessened. After leaving Bamian, Major Talbot returned to join Sir West Ridgeway, while Colonel Maitland journeyed to Tashkurgen, and thence to Chahar Shamba, the headquarters of the Mission, after a three months' journey, during which nearly 1,000 miles of desert was traversed. The survey work was altogether executed under Colonel Holdich's superintendence; he was assisted by three officers of the Royal Engineers. The work done may be understood when we note that while the Russians could put seven trained survey parties into the field, Colonel Holdich had only a staff sufficient to turn out two or three.

Archæology, geology, and natural history were carefully attended to.

The work of the political officers consisted principally in examining into the tribal condition of the Hazaras, Jamshidis, Firuzkuhis, and many other tribes, obtaining information as to the claims of Afghans and Turkomans to the districts under dispute, and sifting and examining carefully the Russian claims, the resisting and refuting of which quite filled up any time which may have been left to them from their other tastes.

Besides the work on the north-west frontier of Afghanistan, the travels of Mr. Ney Elias from Yarkund across the Pamir to Shignan and Roshan are of the highest importance. During his journey he collected much evidence and information with regard to the claims of Bokhara to these Khanates. Mr. Elias travelled quite alone along the Upper Oxus, and eventually joined the boundary Commission at Chabar Shamba, returning to India *viâ* Chitral and Kashmir.

At the same time, General Lockhart, Col. Woodthorpe, and Major Barrow proceeded through Kashmir to Hunza, and thence across the Kilik Pass on to the Pamir. They travelled down the Oxus to Kila Punja, and returned from Zebah through Chitral at the same time as Mr. Ney Elias. The reconnaissance work done by these officers has been kept somewhat secret, but their explorations are of great military value.

Mr. Ney Elias' work consisted in obtaining evidence as to the merits of the Afghan and Bokharan claims to Shighan and Roshan. Russia is extending eastwards, and she now intends to gain influence in Afghan Turkistan by using Bokhara as a cat's-paw; the bridging of the Oxus at Charjui, and the extension of her railway towards Kilif placing her in a favourable position for taking advantage of events in Turkestan, while her complete control over the navigation of the Upper Oxus makes her authority paramount.

The demarcation of the frontier has now defined Russia's limit of advance on the north-west of Afghanistan, and a check has been placed on her aggressive projects. Had more support been given to the Commission at the outset of its work, it is most probable that the desert would still separate Russia from Afghanistan. Regrets for lost territory are now useless, but for the future weak concessions must be avoided, and rights jealously guarded.

The demarcation of the frontier thus placing a patent obstacle in front of Russia which can only be removed by a clear breach of faith with England, has greatly enhanced our prestige in the eyes of Afghans and Persians. Mr. Merk has himself told me that the increased respect shown to him after his last visit, when travelling through Khorassan to England, as compared with his reception after the unfortunate Penjdeh affair, was altogether due to our showing ourselves able to impose some limits to Russia's absorbing tendencies.

A few years ago Russia's nearest posts to Afghanistan were on the Caspian; in the short time of fifteen or sixteen years she has advanced 700 miles, so that Russia and Afghanistan are now conterminous, and with the bridging of the Oxus at Charjui, the facility with which Russia can move towards Afghanistan, from either side of her dominions, has been enormously increased.

This shows us the value of having demarcated the frontier, for had it been left undefined, the encroachments would still go on as heretofore, until, seized by panic at some particularly aggressive movement, we would plunge into an ill-considered war. The last pillars of the frontier have now been placed by Colonel Yate and Major Peacocke, and if we allow Russia to trespass, the fault will be our own.

Afghanistan now stands to us in Asia in much the same light that Belgium does in Europe. Both Liberal and Conservative Governments have pledged themselves to preserve its integrity, so that if we wish our work to bear lasting fruit, we must clearly show Russia by our firmness that she cannot with impunity violate the treaty just concluded, and that we are prepared to resist any attempt on her part to do so. As long as this is done she will avoid breaking through the new frontier with a view to the dismemberment of the Afghan kingdom.

DISCUSSION.

Sir FREDERIC GOLDSMID, K.C.S.I., regretted he had been prevented from hearing the first part of the paper read that evening. There were two points in it to which he ventured to allude as worthy of notice. One was, that the way to Herat was found to be much easier than had been supposed, and that you could drive to it in a carriage by the approaches from the north. On the other hand, it was satisfactory to know that if Herat were to fall into the hands of those who, though our friends to-day might be our enemies to-morrow, the revenues were very much less than they had been supposed to be, and therefore the advantage of the acquisition would be much less than had been reckoned. There could be no doubt that the work of the Boundary Commission had been most admirably performed, and he was glad to hear a summary of it put together in so lucid a manner.

Colonel HOLDICH, being called upon, said he regretted that it was not in his power to refer to the military or scientific work of the Commission, as he was not permitted to do so. Captain Manifold had spoken of the good feeling which existed between the officers of the Commission and the Afghans, and he might extend that remark, and say that the same good feeling existed between the military and scientific sections of the Russian and English Commissions. He should not soon forget the cordial hospitality and good-will he had always received in the Russian camp, and the many pleasant days' work he did with the Russian topographers. If he could say anything to explode the idea that the Russian as a Russian hated the Englishman, he should be only too glad to do so, for nationally, there really appeared to be a very good feeling towards us. When they had left the frontiers, and passed over the Hindu Kush to Cabul, he met with quite as cordial a reception from the military section there as anywhere else. He had previously lived with an Afghan gentleman in his own house near Cabul for some time, and should always look back to his visit with pleasure. There was one geographical point in connection with the paper to which he should like to refer, viz., about the Hindu Kush. The exact limits of the Hindu Kush had not been very well defined, at any rate lately, and on two or three occasions he had noticed in print that parts of the mountains on the extreme north-west of Afghanistan had been referred to as the Hindu Kush, which really had nothing to do with it. [He then pointed out on the map where it began and ended.] It abutted on the Himalayan system, and ceased near Bamian. Beyond that there was no Hindu Kush. From there the watershed continued in two branches, the northern branch, which was represented by the Band-i-Turkistan, from which all the great rivers which watered the plains northward, and the southern represented on the map as Safed Koh. The great difficulty in all that part of the world was to identify names whereby to classify the mountain ranges. For that reason he objected to a proposal he had seen made that the name "Paropamisus" should not be referred to this southern watershed. There was abundant evidence that ancient historians, in writing of the Paropamisus, referred to the true Hindu Kush, but some of them also referred to the continuous watershed right away to the Heri Rud, and he had not been able to find another good name to replace it. Therefore, he saw no reason why it should not be called "Paropamisus." He should have much pleasure in handing round some sketches he had made of the country, only reminding those who looked at them that amateur artists did not sit down to draw the ugliest portions of scenery, and they must not take them therefore as an average representation.

Mr. MARTIN WOOD said that was a most interesting geographical paper. With regard to the obligations we were supposed to have contracted in those regions, there was a great deal of uncertainty and haziness as to how far they extended. The popular impression that we had guaranteed the territorial integrity of Afghanistan was incorrect, because our engagements went no further than was embodied in the agreement with Abdul Rahman that we would support him in the event of any unprovoked aggression if he followed our wishes. This was very different from the idea popularly current, that we were bound to defend Afghanistan, including this very remote and detailed boundary. With regard to the remark about our firm-

ness and so on, he would just ask what we could do to defend that boundary from the Indian side? The only way to do so would be to show our firmness in Europe. If Russia was to be held to her engagements, why cherish the idea of going through all these obstacles which Afghanistan presented even at its best. It was one thing for a well regulated small Commission to go through a country of that kind, but it would be quite a different thing to take an army there. It was exceedingly gratifying to have so much addition to our geographical knowledge, especially with one of these large maps, which, as Lord Salisbury said, ought to form the basis of all our inquiries in that neighbourhood. He had been much pleased to hear Colonel Holdich's expressions with regard to the friendliness which prevailed with the Russian officers as well as the Afghans. Many men who at first participated in the popular idea as to the treachery and aggressive designs of Russia, when they came in contact with the localities and men themselves, had modified their views very largely. Sir West Ridgeway, for instance, though, while a junior officer, he had not had much opportunity of expressing his views, had shown by his article in the *Nineteenth Century* that he was willing to treat the Russians as acting in good faith as much as ourselves, and to recognise, taking a broad view of the matter, that their progress in Central Asia had been simply inevitable.

Sir Joseph Fayrer, F.R.S., said he saw, two or three years ago, at the Zoological Society's Rooms, two or three specimens of pheasant, so like the English as to be hardly distinguishable, but he was told that they were shot on the banks of the Murghab. He should like to ask Captain Manifold if he had seen any of those birds, and could show him on the map the exact locality they came from; if they were associated with any other bird of the same kind, and what kind of cover they were found in.

Captain Manifold said Colonel Holdich could answer the question better than himself.

Colonel Holdich said he was very well acquainted with these pheasants, having found them scattered over a very large area in Afghanistan and Turkestan. They were always found north of the Band-i-Turkestan, and north of Badghis generally, between the mountains and the Oxus. The cover in which they lived was very different to that of English pheasants, inasmuch as the birds lived a great deal in the water, in vast reedy swamps, where they were exceedingly difficult to get at. Another curious feature about them which he had never observed about any pheasant in England was that, if put to it, they could swim. He had seen a wounded pheasant swim across the Murghab. Their plumage was much handsomer than that of the English bird, but the principal distinction was a white bar on the wing. They existed in enormous quantities, and two officers had brought in 70 brace in one afternoon. They were found on the upper tributaries of the Kushk, but chiefly in the large swamps which flanked the Murghab between Bala Murghab and Maruchak. They were also found in the neighbourhood of Maimena, and beyond that between Kilif and Balkh. He did not think they were found again all the way to India, and never south of Herat. They were quite different to the so-called Indian pheasant.

Surgeon-Major Pringle said he noticed on the map the name Kamiab, which meant waterworks, and he should like to ask if it took that name from being the centre of any great system of irrigation in connection with the Oxus. It was matter of common knowledge that at one time Samarcand and Bokhara were in a very different condition from what they were now, which seemed to have arisen from the drying up or diversion of rivers, converting those countries into wastes. After the Russian expedition to Khiva, when he was in camp at Muttra, he saw a lot of camels evidently coming from Bokhara, and on inquiring of the men he found they had been with the Russians at Khiva, that they had left there and come down the Oxus. Having a map of 1873 with him, he got it out and asked them to tell him their route. He found they had come to Khoja Saleh, and across to Balkh, thence to Bamian, and down by Cabul. He had had the pleasure of entertaining a Russian gentleman, and could endorse what Colonel Holdich had said. He had come through the Himalayan passes, and as he was wandering about he invited him to share his tent, where he remained some time, and on leaving gave him his card, and said how pleased he should be to see him in St. Petersburgh. He was then journeying down to Gwalior to inquire into the Buddhist remains there.

Colonel Holdich said it would be somewhat unwise to enter into any modern geographical details, but he might say that the Commission ascertained one fact about the Great Plain of Turkestan, north of the mountains, and they ascertained it in three different ways, viz., by the observations of the Russian geologist working north of the Oxus, by their own geological surveyor south of the Oxus, and themselves, by their own astronomical observations; and that was that the whole of that vast plain was gradually rising at a uniform rate, as far as they could estimate, of some four or five inches per annum. Consequently there has been, no doubt, a great change in the physical characteristics of the country. They could trace the evidences of a former civilisation in every direction, for there was no difficulty in tracing out the lines of canals for irriga-

tion which existed over a great part of that plain, and which had fallen into disuse.

The CHAIRMAN, in proposing a vote of thanks to Captain Manifold, said he had given a very general, and at the same time, accurate account of the results of the survey undertaken by the Afghan Boundary Commission, which had been ably supplemented by the statements of Colonel Holdich. Not only from what had been said, but from what had not been said, they could gather what vast stores of information had been collected. The question put by Sir Joseph Fayrer showed how great a variety of information must have been collected, and it was a very gratifying fact, quite apart from all political questions, that England had once more taken a leading part in acquiring knowledge about these great regions of Central Asia. He should be the last to complain that Russia was doing in Central Asia what we had been for so many years doing ourselves, but he congratulated the country on the great change of policy which had taken place of late. It was now nearly fifty years since there was a great outburst of English enterprise in Central Asia —since men like Burnes, and Rawlinson, and Wood, and Conolly, and others, revealed something of the nature of that country lying beyond the Himalayas. At that time it seemed as if we were about to become familiarly acquainted with Afghanistan and Central Asia, but then for many years everything was closed to our view. The Government of India seemed to adopt the Chinese policy of shutting out, by a great wall of ignorance, any advance into the region beyond the Himalayas. We were threatened with bogies of trackless deserts and impassable mountains, and so on, which it was said would prevent any European army penetrating into Central Asia. We had learnt wisdom, however, by painful experience. It had been found that another country could send troops into Central Asia, overrun vast territories, and acquire them, and the vast deserts and mountains which it was supposed no armies could ever cross ceased to be an obstacle to the courage and enterprise of the European race. Now we had been obliged, very much against our will, once more to pass beyond the boundary of British India, and to find out what lay beyond it, and what we could secure under our own influence in Central Asia. That was a great gain to the English people, because quarrels more often arose out of ignorance and panic than out of knowledge of the real state of affairs. When Lord Palmerston was appointed Colonial Minister, and went to the Colonial Office, he told some of the officials to pull down all those maps and let him see where all those places were, meaning the Colonies. That showed a very praiseworthy desire to acquire the knowledge which would fit him for the position which he occupied; and now that the English democracy had entered on the possession of this vast empire, it would be a great advantage to them to learn something of the geography not only of their own possessions, but of the countries immediately adjoining them. It was disheartening sometimes to anyone who took a real interest in such matters to see how spasmodic and intermittent was the feeling of the English people with regard to what took place on the frontiers of our Empire. Anyone who remembered the great excitement three years ago, when the unfortunate Penjdeh incident happened, how millions of money were voted, and compared that frantic state of feeling with the utter indifference as to what was going on since, must see what an advantage it would be if, instead of this state of occasional panic, and then periods of indifference, we had one steady continuous policy, based on a knowledge of our own position, and that of our rivals and possible enemies, in Central Asia, and upon the consciousness of the resources we possess, and of our readiness and power to defend the territory we had acquired in the East. Instead of precipitating conflicts with foreign Powers, the acquirement of knowledge of this kind, and stating what we intended to do and would permit them to do, were the real means for staving off war. This was perhaps straying a little over the line which forbade the discussion of politics, but they were not discussing party politics, but the general interests. When it was said sometimes, as it was that evening, that we were not pledged to any particular line of action relating to Afghanistan it would seem that all this elaborate work of laying down a boundary had been a mere farce. What was the use of laying down a boundary if we were not prepared to make that line respected as the frontier of our ally? He did not think the Government had taken part in such a work with the intention of never doing anything to defend the frontier thus laid down. Mr. Martin Wood said they were not under any guarantee to defend the territory of the Ameer, but the Russian Government had expressly said over and over again—a pledge first given by Prince Gortchakoff—that the territory of Afghanistan lay entirely beyond the sphere of Russian influence, and that they regarded it as lying within the sphere of British influence, and this boundary had been laid down to procure the observance of that pledge, and that no raids across an undefined boundary should precipitate a conflict between the two mightiest empires in the world. It was a great gain to both countries that such a frontier had been laid down. Everyone must admire what had been recently said by Lord Salisbury, that the Czar of Russia and his Government had shown in meeting our Government not only a conciliatory, but a straightforward disposition. Why was this? Simply because they found that the English were prepared to assert their authority, and to defend the frontier they had laid down. We also had been straightforward for the first time, and instead of intriguing against Russia, and trying to stir up the population in Central Asia against her, and going to war with petty states on one side or the other, we had told Russia what we wanted, what we meant to do, and the boundary we should insist on

being respected. Another important point referred to in the paper was the advantage gained by the peaceful intercourse we had had with Afghanistan since the Boundary Commission had commenced its work. The expenditure of so many thousands of rupees had had a very soothing effect on the Afghan mind, much more than bullets had ever had, and no doubt the extension of railways into the confines of Afghanistan had been of service in teaching the people the value of such lines of communication, and showing them how their construction brought money into the country. We might now safely count on the friendly feeling of Afghanistan, if we carried out an extension of that railway system through the country, which was most desirable, in the interests of the Indian and the English trade. The Russians had shown very great enterprise in commencing the first trans-Asiatic line which had been made, and he should hope that our Government would follow the example, and that we might see our relations with Afghanistan still farther improved in the same way.

The vote of thanks having been carried unanimously,

Captain MANIFOLD, in reply, said he regretted that the paper had not been prepared by one of the members of the Boundary Commission. The matter was of such great importance that there should be a permanent interest in it, and that it should not be taken up only by fits and starts. The work of delimitation had been well done, and he had no doubt that the line now laid down would have the good effect of limiting the advance of Russia in the direction of India. If Russia crossed that line it would be an undoubted *casus belli*, and we could now certainly keep her advance under some sort of control.

TENTH ORDINARY MEETING.

Wednesday, February 15th, 1888; Sir HENRY THOMPSON, F.R.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bainbridge, Herbert J., Malvern-hall, Solihull, Birmingham.
Beaufort, Leicester P., M.A., B.C.L., 3, Paper-buildings, Temple, E.C.
Brown, Joseph, Q.C., 54, Avenue-road, Regent's-park, N.W.
Hussey, Frank T., The Portman Estate Office, The Grove, Cheddon Fitzpaine, Taunton, Somerset.
Wilson-Barker, David, 66, Gloucester-crescent, Regent's-park, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Chancellor, Albert, The Retreat, Richmond, Surrey, and The Lawn, Ascot-heath, Berks.
Claudet, Arthur Crozier, 2, Stirling-mansions, Canfield-gardens, Hampstead, N.W.
Hannay, James Ballantyne, Cove-castle, Loch Long, N.B.
Kendall, Arthur G., B.A., 13, Porchester-square, W.
Mann, Frederic John, 17, Essex-street, Strand, W.C., and 110, Tulse-hill, S.W.
Murray, A. H. Hallam, B.A., 50, Albemarle-street, Piccadilly, W., and 30, Grosvenor-road, S.W.
Russell, John, Anchor Brewery, Chelsea, S.W.
Twivey, Arthur, 151, Broad-street, Five Ways, Birmingham.

The paper was read—

TYPE-WRITERS AND TYPE-WRITING

BY JOHN HARRISON.

Although but recently attracting serious attention in England, the type-writer has been known and used for several years by the few who, from a desire to be delivered from the manual drudgery imposed by penmanship, or from curiosity, were paving the way for a new order of things in the brain world, wherein, up to that time, the pen had reigned supreme.

Surely every writer, whether of the higher order of intellect, when attempting to catch an all too fleeting thought, or a copyist, transcribing other men's ideas at so much or so little per folio, has at some period longed for a simpler, less exacting, and more rapid means by which to accomplish the end.

An innovation, while it invariably finds supporters (because there are they who will support anything), is generally received with scepticism by the majority; and in this age of invention our hopes are so frequently raised by promise only to be thrown down that scepticism becomes justified. But I think it true that whatever shows a distinct gain to mankind is recognised sooner or later, and it is at least certain that each successful invention or discovery paves the way for the next, so that men wonder less and less at methods and processes producing results which our ancestors would have deemed impossible.

Intellectual labour seldom coaxes the cunning of the inventor to devise means by which it may be relieved. True, the goose quill has been exchanged for the gold pen, but that does not help the hand to keep pace with the brain, nor to any extent alter the hieroglyphics into legible writing. But at last modern invention has espoused the cause of the penman, and, in the type-writer, has given to the world of letters an instrument that banishes at a sweep

cramp in the hand and illegibility, and doubles, nay trebles, the speed of writing.

There is an impression that the type-writer is an American invention pure and simple; but this is hardly true. The first machine for writing in type was invented by an Englishman, one Henry Mill, who took out his patent in 1714. His instrument was clumsy and useless, but it started the idea. The masses wait for the leaders to point out their needs.

To America must be conceded the honour of the ultimate and practical result. A writer in the *Century Magazine* gives this brief description of its origin :—

"In 1867, two inventors, printers by trade, G. Lathom Sholes and Samuel W. Soulè, were at work in Milwaukee on a machine for numbering the pages of blank books. Mr. Carlos Glidden, also an inventor, saw the machine, and said it would be better to use it for printing letters instead of numbers. A mere casual observation, and yet it marked the birth of a great invention. Nothing was done about it for some time, when there was a report in the 'Scientific American' of a machine that would print one letter at a time on paper. This was invented by Mr. John Pratt, of Alabama, then residing in England, and while it does not appear to have come to anything, the description of it spurred the Milwaukee inventors to efforts in a wholly new direction. The idea was a good one. Capital believed in it, lent its aid, and in time the machine came, with all its crudities, to the great Remington shops at Ilion, which have turned out millions of rifles carrying misery and tears to mankind, but which were destined to manufacture weapons of precision for the advancement of peace and civilisation, making it easier for the widow, the yonng girl, and the hard-worked clerk to earn a living, and saving a thousand small miseries in every counting-room, office, and literary study. Here it took on many improvements, and became a really practical machine that could be manufactured on a commercial scale."

If we pause for a moment to consider the conditions called for in such a machine, we shall readily see that they are so exacting and comprehensive that at first sight they might well seem insurmountable. It must be able to impress at a stroke any letter of the alphabet, both capital and small, and also the figures, it must set them in straight lines, in the thousands of combinations called for by the hundreds of thousands of words in the various languages. Each letter must be imprinted in its proper place and position, and a correct space left between each word. Punctuation marks must be possible in all their variety, and any word or phrase underscored at will. The length of the lines must be under control. It must write on any portion of the paper we desire. It must exceed the pen in legibility and rapidity. It must occupy but a small space, be simple in action, easy to learn and manipulate, and be durable.

The progress of the type-writer was slow at first; prejudice met it everywhere, and a thousand and one objections were raised against its adoption. Few there were who spoke in its praise. But all at once men seemed to grasp the idea of what it really was, what it would do, and, in short, how there had been placed in their hands a machine to help the thinker and the writer; and the productive faculties of the great shops were tested to their utmost. Fortunately, there were men at the head of the enterprise who were shrewd enough to realise that the machine, although capable of great results, even then was only in its infancy; that they had given birth to a new industry, in which there was certain to be a competition. Instead, therefore, of waiting for the inevitable, they set to work to improve, engaging the cleverest students of mechanics to be found, regardless of cost; and thus, year by year, the machine became altered, modified, and simplified, until at length the type-writer as we know it to-day, with all its wonderful possibilities, became an established fact. Even now, a lingering prejudice against it exists in some minds, and an oft-expressed doubt of its capacity to perform the work ascribed to it. We are creatures of habit, after all, and resent innovation. There seems a sort of absurd incongruity in imagining either Shakespeare or Bacon writing his immortal works by the aid of this wonderful machine, but it is so merely because of the pen's priority. Could we transpose their order, the sense of contradiction would be reversed. And the idea will present itself that, had these men of large intellects possessed this facile means of transmitting their thoughts to paper, they had bequeathed even greater heirlooms to the ages that came after them. And grand old Milton, with his sightless eyes, that yet could see the mystery of other worlds—had he possessed this scimitar of power, would have been independent of his flippant daughters, and with his own hand could have given us thoughts fresh from his teeming brain; for with it the blind can write almost with the ease of those who can see.

As I shall have the pleasure of showing you various type-writing machines in actual operation, I shall content myself now with giving a

bare description of the construction of the "Remington No. 2" and other leading type-writers. We will take the "Remington" first.

On the top of the machine are two rollers, one of hardened rubber and the other of wood, and between them passes the paper. Beneath these rollers is a circular basket-like frame, from the top of which depend at regular intervals short bars of metal, and at the end of each bar is fixed a double steel type. In front is the key-board of small circular keys arranged in terraced rows. When one of the keys is struck it presses directly on a lever, which, by the aid of a connecting wire, instantly raises a corresponding type-bar. The point of percussion of the type and paper is at a common centre, and by a most ingenious and delicate arrangement is mathematically correct. It is obvious that if the paper remained stationary one letter would be written over the other, but it is made to move the required space by an automatic piece of mechanism, which, while exceedingly simple, is, nevertheless, absolutely effective, the action being brought about at the instant any key that has been struck is liberated by the finger. The ink is supplied by means of a prepared ribbon, which also moves automatically immediately beneath the paper, and the type striking this against its surface leaves a clear impression. A light touch of the thumb on a narrow wooden bar in front moves the "carriage"—*i.e.*, that part which carries the paper—the distance of a letter, and as it sets in motion none of the type-bars no impression is made, the operator being thereby enabled to space the words.

When the end of the line is nearly reached, warning is given to the operator by the ringing of a little bell, and a simple movement of the hand returns the carriage to its first position, and at the same time shifts the paper into position to receive the next line.

It has been said that at the end of each type-bar is a double type. The cylinder, around which the paper is drawn, presents a surface to but one of these types at a time, but by the pressure of a key arranged for that purpose, the position of the carriage is altered so that the second instead of the first type comes into contact with the ribbon, and makes an impression. This ingenious conception is one of the peculiar recommendations of the "Remington," for it will be seen that, as each bar does duty for two sets of type, the number of keys necessary to work the machine is halved. Thus, with 80 characters we have but 40 keys. Far from rendering the machinery complicated, it reduces the trouble of learning, and is a relief after using a machine fitted with a bewildering number of keys. By the manipulation of a spring fitted in the front of the machine, the natural order of things is reversed, and the machine can be made to print entirely in capital letters while both hands are being used.

Before entering into the question of what the type-writer can or cannot do, I must mention two other prominent machines. It would be useless for me to take up your time with a description of the others, as the smaller and lower priced machines are not provided with key-boards; and, although the devices used for printing are in almost all instances exceedingly ingenious, it has been proved by actual test that they cannot compete with the key-board machines in point of speed. In passing, however, I may state that the "Hall," the "Columbia," and the "World" type-writers are admirably adapted for the traveller to whom rapidity is not essential, as they are low-priced, portable, and, in competent hands, do beautifully clear work. The speed possible on them is, however, little greater than that attained with ordinary longhand.

The two more pretentious machines referred to are the "Caligraph" and the "Hammond." The first of these, namely, the "Caligraph," is an offshoot from the "Remington," and without much doubt is the second best type-writer in the market. (Of course, in whatever remarks I may make, I can only hope to give the benefit of my experience.) Like the "Remington," the "Caligraph" is a type-bar machine, and is operated by a key-board. Its inventors, however, while endeavouring to manufacture a type-writer as nearly similar to the "Remington" as possible, were obliged, in order to refrain from infringing its patents, to go very far out of the way to effect results naturally brought about in the parent machine. Thus, for instance, they were forced to reverse the levers, which they hinged in front instead of the back, thereby losing a large amount of leverage, and as a natural consequence the force required to manipulate the keys was materially increased. This arrangement also necessitated an alteration in the keys themselves, which instead of being arranged in terraces or steps, as in the "Remington" machine, are fixed on an incline, and in place of being free, the support of each key has to work in a tube, piston-fashion, which naturally increases the amount of friction.

Again, being unable to adopt the system of double type on a single bar, the inventors were forced to devote a separate key to each letter, thus doubling the number of keys, and the area over which the hands have to travel. In place of the simple space-bar for the division of words, &c., a double attachment was devised which stands out at either side of the machine. This was a serious mistake, as the operator invariably uses the fourth finger of each hand to depress them, which brings into play precisely those muscles that are first affected with cramp in the hand of the writer. In spite of these objections, the "Caligraph" has its many warm admirers, and is undoubtedly a good machine. Its speed is not so great as the type-writer, nor can as many manifold copies be made at one writing, but in contests it has at least come second.

The "Hammond" is built upon a totally different model to either the "Remington" or the "Caligraph," and is technically known as a "wheel machine;" that is to say, that instead of the type being placed at the end of bars they are arranged round the segments of an oscillating wheel. The key-board is semi-circular in shape. When a key is struck, the wheel rotates until the type corresponding to the key struck is brought into position, when a small hammer, having a mechanical action, is liberated, and flies against the surface of the type. The paper and inked ribbon are, however, run between the type and the hammer, and, as a consequence, an impression is made on the paper. This machine is noted for the elegance of its shape and construction, and for the fact that its type is interchangeable. This latter statement must not, however, go unqualified. A wheel having differently graven type can be readily substituted for the one in use, but owing to the fact that all the type-wheels have to be of a similar size, the space possible for the type itself to occupy is limited, and the result is that the variety is more in name than in reality, so far as ordinary observation goes. The chief objections to this machine are that it is noisy, and after a little use does not make a very clear impression, every letter being overshadowed by a ghost of itself. It cannot produce satisfactory manifold copies, nor is great speed in writing possible, for the reason that after printing a letter the wheel is obliged to return to its starting point before it can begin to revolve again when the next key is struck Also, from the type being cast in vulcanite, it gets flattened by the repeated blows of the hammer; and lastly, owing to the extreme complication of its machinery, when it once gets out of order it is a costly matter to have it repaired. The "Hammond" has not yet been long enough on the market for one to be able to speak with certainty as to its durability.

The first and greatest gain obtained by the use of the type-writer is speed. It is no empty statement to say that, with very little practice, anyone of ordinary intelligence can write twice as fast with it as with the pen, nor is it the least exaggeration to affirm that an adept can do as many as 75 words per minute. In exceptional cases over 100 words have been written in the same space of time, although this rate of course could not be sustained for long. The average professional operator can at least keep up a speed of from fifty to sixty words per minute. Compare this with the speed of the ordinary writer, and the gain is at once appreciated. As this statement may seem improbable to those who know that figures are too frequently only "figures of speech," I shall presently be able to substantiate that which I now affirm. Asking you to take wbat I have promised to verify for granted for the present, it will readily be seen that with the type-writer a given amount of work can be done in half the time than if performed by the pen, or, in other words, that one man can do the work of two. This is not fallacious or exceptional reasoning, but has been proved in tens of thousands of cases.

The second gain is increased legibility—the very poorest specimen of type-writing being easier to read than the best sample of penmanship. I venture to say that there is no one present who has not at times puzzled over a letter presumably written in the English language, and wished for a dictionary of signs and symbols with which to make a translation.

For official documents the legibility of work done with the type-writer is universally admitted in those departments where it is used. Legibility—besides the moral effect it has on the temperament of mankind—minifies the chance of errror. The Chief of the Department of Militia and Defence at Ottawa, points out that there is also a gain in dividing up a manuscript or printed document, to enable several clerks to take part in copying it sumultaneously, the resulting copies, from the type-writer being uniform in character and arrangement. There is no doubt that the benefits derived from this fact alone are uni-

versally appreciated in all public offices where the machine has been adopted.

A further gain is condensation. Everyone who knows anything about such matters is aware that a bulky manuscript will shrivel into insignificance when handed over to the compositor. But in Government Departments, where to the writing of books there is no end, condensation is a thing greatly to be desired.

Moreover, with the type-writer it is an easy matter to obtain many copies at one writing, the number being regulated by the thickness of the paper employed. Manifolding is done by placing alternately a sheet of writing-paper and one of carbon paper, and running the whole between the rollers, the force with which the type-bar strikes the surface being sufficient to make an impression on all the sheets. Added to this, perfect copies may be made in the ordinary copying-press, and if a number are needed, they can readily be had by employing almost any of the popular duplicating processes; or, by using a specially prepared ink, the writing can be transferred direct to the lithographic stone.

To the man of business the type-writer is a great boon. Instead of being overwhelmed by a mass of correspondence, and haunted day and night by a residue of important letters postponed to the morrow, he is able to cope with the heaviest mail. A clerk is engaged who is a rapid shorthand and type-writer amanuensis. The principal dictates to him the answer to each letter as it is opened, and when he has received them all, he transcribes them on the type-writer in about half the time it would have taken to do with the pen. Meanwhile the business man has been able to go about his business, and if time is money, he ought to feel the benefit of an extra half-day every working day in the year. All that remains for him to do is to read the letters—which even to him will be an easier task than if it were in script—and sign them. They then go to the junior clerk, who press-copies them in the usual way. The business man can leave earlier, and go home with no anxiety produced by the thought of unanswered letters to play havoc with his digestion. It is only inefficient clerks, as a rule, who have a horror of the machine. A labour-saving device is always a bugbear to the incompetent.

One of the most remarkable features in the revolution being brought about by the type-writer is that it has done more to solve the women problem than anything else. As civilisation takes on extra refinement, and education becomes almost universal, so it grows harder for the lower middle-class woman to find suitable employment that is sufficiently remunerative for her needs. If an adept in type-writing, she will certainly be able to do well, as the demand for efficient operators at present exceeds the supply. It is almost essential that she should have a knowledge of shorthand, but, as a rule, women of intelligence do not find this difficult to acquire.

The introduction of the type-writer does not of necessity mean that employment will be taken away from one person to be given to another; it has created a need, and women of education are peculiarly fitted to supply it.

As an aid to education it has been widely recognised in the United States, and has been adopted in the public schools in Chicago and other places. Professor J. G. Deupree, of the Mississippi College, Clinton, Miss., says:—

"Type-writing is making its way in our schools. It is the experience of those institutions where type-writing has been taught that composition lessons have become more profitable. Printers decide upon the correct spelling of a word simply from its appearance. This is philosophically correct, and the success of printers in becoming good spellers is simply proof of the assertion. So far as spelling is concerned, the same gratifying results will flow from type-writing as from type-setting, and for the same reason, *i.e.*, it trains the eye to recognise correct forms. The spelling is done by sight, not by sound."

A leading teacher in Danville, Ill., in advocating the general adoption of the type-writer in the public schools, urges that, aside from the mere work of manipulating the machine, the pupil would learn "(1) to spell words correctly; (2) to use capital letters properly; (3) to use punctuation marks; (4) correct spacing and paragraphing; (5) correct arrangement; (6) the correct use of language;" and adds:—"Type-writing as a distinct study is already found in the curriculum of many of our colleges and commercial schools, and in some of our public schools, and wherever introduced it has added to, rather than detracted from, the interest in other studies."

The upright position assumed by the operator is certainly conducive to health, and the prevention of scrivener's palsy or writer's cramp is an additional inducement for penmen to adopt this machine. Dr. Frank Woodbury, of Philadelphia, who has studied the matter closely, says:—"One of the most useful of modern inventions is the type-writer, which I

consider very efficient in preventing writer's cramp;" and Dr. Lincoln, who is chairman of the Department of Health of the Social Science Association, declares it to be serviceable even after the disorder has been developed.

Authors are almost unanimous in asserting that the work of composition is rendered easier by the employment of the type-writer; ideas flow more readily, and the absence of fatigue tends to keep the brain clear. Indeed, after one has thoroughly mastered the machine, it becomes as much a part of the writer as does the pen. Nor are the eyes strained, for the simple reason that they are hardly used at all. Skilful performers on the pianoforte very rarely do more than glance occasionally at the keys, and there is no greater need for the operator to do so when using the type-writer.

Editors are more likely to read a manuscript written in type than wtth the pen. Compositors and proof-readers find their labour materially decreased. In fact, so thoroughly is the type-writer appreciated by publishers that many leading houses now employ a staff of operators to transcribe the pen-written manuscripts on the type-writer before sending them to the compositors. In many instances they find this sufficient proof to return to the author for correction; much time and expense being thereby saved.

Offices for type-writer copying are now being opened in the leading cities, and they are not only proving to be paying concerns, but they give employment to hundreds of educated ladies of limited means.

The Western Union Telegraph Company and the Associated Press now use the type-writer for receiving messages direct from the wire. In this way they dispense with the stylus in making manifold copies, and are enabled to produce as many as fifteen impressions simultaneously as fast as the message is received.

The offices of the United Press Association also employ the type-writer for a similar purpose, and these companies have several hundred machines in daily use.

In the Executive Mansion, at Washington, the telegraph operator receives all messages direct from the wire, using a giant sounder for concentrating the sound, so that it is not interfered with by the slight click of the type-writer.

The United States Government have adopted the type-writer very largely; it is found in numbers in almost all the various departments, and has given the greatest satisfaction. I shall be able to show to the members at this meeting many testimonials from the heads of these departments, speaking in the highest terms of the saving in time and money effected by its use.

Almost without exception, the machines employed are of the "Remington" manufacture. In the Department of State there are now twelve in constant use for reports, copying, and correspondence. In the Navy Department over 50 for correspondence, copying, and making records. In the Bureau of Navigation of this department, there have been some 25 additional machines purchased for the use of the war ships.

In the Bureau of Equipment and Recruiting, the type-writer is used for all official correspondence, and for copying all official correspondence and letters, despatches, &c., received there. They are type-written on heavy paper, and afterwards bound into book form for reference. Commander Schley, Chief of the Bureau, was in command of the Greeley Relief Expedition, and his report, submitted to the Senate, was written on a "Remington" type-writer, a press copy of which was taken for the use of the Bureau. In the Treasury Department many of these machines are in use, although I am unable to state the exact number, but in 1885 they had 15, and have been steadily adding to them since. All official and legal papers are type-written.

In the annual report of Attorney-General Brewster, in 1884, the fact was stated that with the number of machines he then had in use, at least twice the amount of work was done as when the copyist used the pen. He strongly advocated and recommended the purchase of many more machines, which was approved, and to-day there are some twenty-five type-writers in constant use in this department.

Fifteen type-writers are employed in the Post-office department for copying official papers, writing original documents, for correspondence, and for executing manifold copies of tabular statements used in the Second Assistant Postmaster General's office of the division of railway mails and star routes.

The question of the permanency of the inks used having arisen some time since, and as this is a most important matter, and one that will be certainly raised in England as the type-writer comes into more general use, I may perhaps be excused for reading the following official letters on the subject:—

"Department of the Interior,
"United States Patent Office,
"Washington, D.C., September 16, 1887.

"*To the Honourable Commissioner of Patents.*

"SIR,—In reply to the queries contained in the letter of the acting secretary of the United States treasury, of date August 22, 1885, which I return herewith, and which reads as follows :—

"'1st. Are the impressions made by the type-writer permanent ?'

"'2nd. Are copies made on the type-writer by the use of carbon paper permanent in their nature ?'

"I have the honour to state, in reply to the query 1, that I have personally interviewed Mr. John Underwood, at 30, Vessey-street, New York city, who furnishes to the several type-writer agencies of this city the ribbons used by the United States Department, and from whom, in addition to my own experience and experiments made on the action of the various copying inks and ribbons, I have obtained the following information :—

"There are ten different ribbons used, five being copying ribbons and five recording ribbons.

"The word 'permanent,' which appears in the inquiries presented should be understood as referring to the power of resisting obliterations by the action of the light, of washing, of treatment with acids and alkalies, as ordinarily practiced by those operating to remove the ink. The colour of the ink may be changed by such treatment (as from blue to black, black to green, and other similar changes of shade), but whether change of colour be produced or not, the ink is not effaced; it is legible, the letters not obliterated, and therefore such ink may be said to be permanent.

"This is eminently true of the black record ribbons.

"Another ink is furnished called the black indelible copying ink, which has also the above-mentioned properties of permanence.

"The ribbons of other colours than the foregoing are admitted by Mr. Underwood, and found to be fugitive, red and purple particularly so. They for this reason should not be used for recording permanent records; these inks cannot be styled permanent.

"It may be stated here that the same ink has different results as it is applied on paper by the ordinary writing pen, and as applied to similar paper by the type-writer. In the latter instance, from its soaking more deeply by the impact of the machine, and being forced below the surface of the paper, it is more difficult to be removed or reached by chemical agents applied, therefore an advantage accrues in the use of the type-writer over the pen."

"(Signed) THOMAS ANTISEL,
"Examiner of the Chemical Division."

"Columbia College, New York.
"March 29, 1887.

"I have carefully analysed the type-writer ribbons you sent me, and now send you a report on the same.

"Type-writer ribbon called No. 1 (record ribbon), produces a colour that is as permanent as that produced by printer's ink. Any writing done with this ribbon will be no more affected by time, light, age, and acids, than will the printer's ink, which is as durable a colour as we know of. The writing may be affected though by some oils, but printer's ink will also be affected by the same oils.

"Type-writer ribbon called No. 2 (indelible ribbon), produces a colour, both in the original proof and in the copy, that is to all intents and purposes permanent: that is to say, that although both proofs and copy will fade a little temporarily in sunshine, and on long exposure to ordinary light, they will both regain their colour at the return to shade. The temporary fading of the original proof is less than that of the copy.

"(Signed) ROLAND G. ROOD,
"Hon. Assistant in Physics, Columbia College, N.Y."

The type-writer is, in its way, as great an invention as the telegraph or the telephone, and the time is rapidly approaching when its advantages will be as widely recognised here as in America. It wins its way in the face of prejudice, and those who use it sufficiently long to discover all that it really means to them never give it up. Its operators become devotees, and to those whose lives are overcast with the eternal night of blindness, if it has not given them light, it has, nevertheless, helped them nearer to their fellow men.

The type-writer is an essentially practically blessing. That charming poet, Austin Dobson, says :—

"With slower pen men used to write
Of old, when 'letters' were 'polite:'
In Anne's or in George's days
They could afford to turn a phrase
Or trim a straggling theme aright.

They knew not steam; electric light,
Not yet had dimmed their calmer sight;
They meted out both blame and praise
With slower pen.

More swiftly now the hours take flight,
What's read at morn is dead at night;
Scant space have we for art's delays,
Whose breathless thought so briefly stays,
We may not work—ah! would we might,
With slower pen.

Perhaps that is a good wish, if the poet refers to modern poetry, but for the sturdy issues of life, for business, put wings to the pen, give us speed! We have it in the type-writer.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said he thought it would be desirable to limit it to the most practical points; and there were two questions, he thought, to be decided. The first was what the

type-writer could do as compared with ordinary writing, or how far it was superior; because as a really first-rate type-writer cost about as much as a cottage pianoforte, people would like to know before investing to that extent what the capacities of the instrument were. Since the meeting had commenced, a two guinea machine had been placed on the table, still they all knew that if they wanted an effective type-writer which would go considerably beyond what could be done by the pen, a good price must be paid. Then, secondly, having settled that, there remained the question, which was the best for the purpose. It appeared to him that there were three points to be looked to, rapidity, simplicity of construction, and durability, or unlikelihood of getting out of order. The two latter points he could not say anything upon, with regard to the three machines which were admittedly in the front rank, the "Remington," the "Caligraph," and the "Hammond," but the question of rapidity undoubtedly came first. He had recently made test of what could be done by the pen, three or four friends sitting down and writing for so many minutes by a watch, both copying from a book, and having the words dictated. The average was 35 words a minute, one gentleman writing 124 words in three minutes, and a young lady, who had done a good deal of copying for him, writing 141 words in three minutes. He would ask Mr. Harrison what he thought was the average speed of writing.

Mr. HARRISON said it varied so much that there was a difficulty in giving any average, but he was informed that a good lawyer's clerk was expected to write about 30 words a minute. He should be inclined to put it from 20 to 25.

The CHAIRMAN, continued, turning to what the type-writer could do, it was said that it doubled the speed of the pen. If so, it was a machine of enormous value, but he had never got anything like that out of it himself; but then he had not practised sufficiently to become proficient. He could never get much beyond the speed of the pen, being certainly a rapid writer. It was said that a skilled operator wrote from 50 to 60 words, which was at least an increase of 50 per cent., which was very good, and he felt certain that it must be a skilled operator who could produce one word a second, words averaging four or five letters each, and there being also a stroke between each word for the space, which was not required in writing. As practical men they wanted to know exactly what the type-writer could do; there was no question it was faster than writing, but they wanted an exact valuation of it. With regard to the other question, which was the best machine, it was no doubt true that some of the cheap machines were very good, but if you could not write faster than with the pen why have them at all? In conclusion, he would say that he thought a good deal might be done to help the pen as against the type-writer. Spelling might be improved very much, and with a little arrangement we might get rid of dotting the "i's" and crossing the "t's," which was a great obstacle. He spoiled as much good writing-paper as most men, and he disliked that dotting and crossing immensely. There might also be simple marks introduced for "ing," "ion," &c., and with some of these improvements he thought the pen might almost be matched against the type-writer, unless that were improved also, as no doubt it would be.

Mr. BRUDENELL CARTER said his experience of the type-writer now extended over twelve years. He first had an old-fashioned Remington machine, which had a treadle underneath to take the carriage back; then he exchanged that for one with a side lever, worked by a catgut, which not unfrequently broke; then that was exchanged for one with the handle as shown in the present machine, and latterly he exchanged again in order to get the most improved machine with large and small letters. He had no experience of the "Caligraph" or "Hammond." His own impression was that the speed of the Chairman's friends, as shown in the three minutes' test, would not have been kept up for twenty minutes. He found that after writing for a time, especially writing fast, the muscles of the thumb and grasping finger began to get very troublesome; and some years ago, when doing a good deal of reviewing, he found the work of writing and copying extracts so trying to the muscles of the hand, that he was on the point of relinquishing it altogether, when the machine first came under his notice. From the moment he possessed it his troubles vanished, for he had frequently on wet Sundays used it for eight hours continuously without fatigue. Although he had made his finger-tips sore, he never had any difficulty with the muscles. When he first got the machine he had no instructions, and began by picking out the letters with his two forefingers, a habit which he had not taken the trouble to unlearn when he knew better. The result was that he never had been, and never would be, a quick operator, but he found his speed was about double what it was in writing. He was frequently engaged in work which had to be done against time, and found that what used to take him from one hour forty minutes to two hours could be easily done in an hour. It was also a great advantage to be able to correct the copy before sending it to the printer, which he never could do properly in manuscript. The entire absence of weariness enabled one to think better, and a portion of the gain in time was owing to the absence of pauses in the work. Another great advantage was that you could calculate exactly how you were getting on with your work; if you had to write twenty pages, you knew when you had half or three parts finished, and could marshal your facts and arrange your material accordingly, which one could never do with the pen. The absence

of corrections made a great saving of expense in writing for the press. There was only one drawback; that the printers put type-written copy into the hands of the worst compositors, whilst bad writing was always given to the most efficient. On these three grounds—economy of time, of manual labour, and saving of corrections—he was strongly in favour of the type-writer; in fact to him it was indispensable.

Mr. DAVISON said there seemed an idea amongst commercial men and clerks, that if a machine would do twice the work of a writer with the pen, salaries must be cut down and clerks discharged, and this, he believed, prevented the introduction of the type-writers in many large houses. But this was quite a mistaken idea. If you could write faster you could occupy your time in doing something else, and you could get the letter finished in time for mail. As regards the "Caligraph," which he represented, Mr. Harrison had made a mistake in saying that the manufacturers could not use the invention for shifting the carriage to produce the capitals; they could use it if they liked, but found from experience that it was a mechanical mistake. The levers in the "Caligraph" also were superior, as any mechanical engineer would admit; less depression was required, so that you could strike them faster. It was a great advantage to do away with the vibration which the shifting of the carriage occasioned, and there were other little improvements in the mechanism which he would be happy to explain. As to the speed, Mr. Harrison had remarked that the machine which produced a character at one finger stroke was the fastest, and that was just the advantage which was claimed for the "Caligraph."

Mr. NOBLE SMITH said his personal experience of the type-writer was very limited, but he had considerable knowledge of its use in the hands of others. He had found, in reading papers before societies and so on, that sometimes he had a difficulty in reading his own writing, but when type-writing was introduced he at once saw its value, and since then he had always had his papers copied, which had conduced not only to his own comfort but no doubt to that of those who had to listen to him. No doubt rapidity was important, but after all, in his mind, it was a secondary matter. The legibilty of writing, and the saving of corrections, was in his view the most valuable point. He believed in the division of labour, and he had hitherto made use of the offices which were established for copying. He found that his mind could not go quicker than he could write, so he sat comfortably in his arm-chair, and jotted down his ideas in pencil, sent them off by post to be copied, and sometimes was surprised to find how well they turned out. He hardly thought it was correct to say that type-writing would solve the question of employment for the lower middle classes, because it required a good deal of education. In fact, that was the difficulty he met with at first. It was all very well with a novel; perhaps any one could copy that; but when it came to scientific, and especially medical matters, a good deal of education and technical knowledge was required to do it properly. No young lady should take up this unless she were well educated, and they would have to work very hard to conquer all the difficulties. Again, the question of health was a very important one. He had been several times into Mrs. Marshall's office, and he noticed that the best workers there assumed a very much better posture than was usually occupied in writing. He believed more harm was done by bad postures in writing than in almost any other occupation. As a rule clerks—and they were a very large body—were round-shouldered and flat-chested; and this was not only a question of appearance; it meant that their lungs were compressed, that they had a difficulty in breathing, and their whole vitality was lowered. Sometime ago he made an inquiry for the School Board into the question of desks and seats, and he almost always found that the children were in a constrained position. The only suggestion he could make was that the slanting style of writing, which necessitated this should be exchanged for upright writing. The type-writer would obviate this entirely, but he did not know whether it could be introduced in schools.

Mr. WINTER BLYTH said he had had experience of three kinds of type-writers—the "Remington," the "Hall," and the "Columbia," and as so much had been said of the merits of the first, he would say a word on some of its disadvantages. In the first place you had a ribbon, which he thought a great mistake. When the air was unusually dry it sometimes marked very badly, whereas when it was saturated with moisture, you often got a smudge. We should never have a perfect type-writer until the type struck directly on the paper. It must be on the "Remington" or "Caligraph" principle, so that you could use both hands, but the type should be inked by the same stroke, as in the "Columbia," and strike directly on the paper. Directly any substance was interposed between, there would always, after a time, be a certain indistinctness about it. With such a machine as he referred to, printers' ink might be used, which they knew would last for centuries, whereas all those now used being made with aniline, he thought there was great doubt as to their permanence, notwithstanding the evidence which had been read. The small machines had been rather sneered at, but they had their advantages. You could not write fast with them, but many persons wrote very illegibly, and if these machines only wrote as fast as these, and the writing was legible and portable, they must be of great use. He should think the "Remington" could even be used for reporting, if the reporter could carry it about with him, and if it were made noiseless, for, with the great speed claimed for it, by leaving out the vowels, and perhaps having special

types to represent frequently-recurring words, it ought to be rapid enough for that purpose. He had given up the "Hall" and "Columbia" machines, because they tried his eyesight too much; the "Columbia" by the rapidly-vibrating needle, and the "Hall" by the letters being sunk, so that, unless you had the light directly over it, you could not see them clearly. The letters also were made of rubber, which would never give so good and clear an outline as steel.

Mr. H. Trueman Wood said he had had a good deal of experience of the type-writer, but he would first add a word or two on the history of the invention. The machine by Pratt, which had been referred to, was described in that room in 1867, when it was invented; a model was left there for some time, and though it got broken, he was himself able to put it so far into order, that some sort of work could be done with it. The model was now in the Patent Museum. He would also refer to the type-writers made by Sir Charles Wheatstone, which were for some time in the possession of Mr. Robert Sabine, but where they were now he did not know. Perhaps Mr. Stroh, who assisted Sir Charles Wheatstone in the construction of many of his apparatuses, could say something about them. As to modern type-writers, he had probably used them as long as anyone present. One was brought over here in 1875, and having had it lent him for a time, he bought one. It had only capital letters, and he had since changed it for a more modern type, but he must say that the device in the "Remington" for changing from small letters to capitals was very unsatisfactory. He did not say it was not the best that could be made, but holding down one key while you struck another was inconvenient and troublesome. At one time he thought the old-fashioned form, with only capitals, was preferable, but printers did not like copy all in capitals. His experience was almost precisely that of Mr. Brudenell Carter, that he could work about twice as fast as with the pen; but as most of his work was not copying, but what was called original writing, he had not much opportunity of finding out how fast he could write. For a long time the great drawback was that you were thinking of the instrument and not of what you were writing; the words did not seem to flow instinctively as in writing, but that wore off eventually, and you could work away without thinking at all of the apparatus. Being rather shortsighted, he had to stoop over his writing, and after a long spell got very tired in the back, but with the type-writer he could sit upright, and could go on on a wet or even a dry Sunday for a long day's work, without being fatigued as in writing with the pen. Still the type-writer had some drawbacks. Being a machine, it was liable to get out of order, and would sometimes do so at the most inconvenient times, when stopping to put it right cost you more time than you saved by it. He did not think it was practically useful except for long jobs. To get out the machine and see that it was all right, and dust it, was not worth while for a small bit of work. The great enemy of the type-writer was dust; and you had to spend a good deal of time in cleaning it. With respect to the various machines, he only knew the "Remington" practically, but he had been trying the "Caligraph" a little that morning, and he thought it had an advantage in the capitals being on separate keys, and not requiring the carriage to be shifted, but he did not like the space between the operator and the keys.

Mrs. Marshall said she was a pupil of the first lady who opened a type-writing establishment in London who came from America. She had now been established since 1884, and since then her pupils had opened offices in Edinburgh, Oxford, Liverpool, and Cambridge, and a great many in London. They were all doing well, and a great many ladies were employed in them. It went without saying that a lady operator must be well educated, as the matter which went through her hands was of such a varied nature, not unfrequently scientific. It was generally wanted in a great hurry, and authors seemed to imagine that you had only to put a piece of paper into a mill, give it a twist, and at once get a clear fair copy; but this was a great mistake. A key had to be depressed for each letter, and every word had to be spelled out one by one, which took a good deal of time. The clerks in her office worked at a speed varying from fifty to sixty words a minute during the whole day. She had not timed herself for two years now, but on one occasion she took from dictation, manifolding at the same time, for two hours consecutively, at the rate of forty words. It was a remunerative as well as interesting occupation for women, and a lady of fifty could become as expert as one of fifteen, if only she had deft fingers. There was no need for stooping, if the seat were properly adjusted, which was quite as important in this work as in pianoforte playing. Many people had the seat too low, and thus did not get proper command of the keyboard.

Mr. W. Lassetter, representing the "Hall" and "Hammond" machines, said any one who found an inconvenience from the letters in the former machine being depressed could have an additional plate. He should advise intending purchasers to inspect all the machines at the different factories, and then form their own opinion which was the best.

Mr. W. Chisholm thought the Chairman had summed up the qualities necessary in a type-writer; it must possess rapidity, simplicity, and durability. At the *Mining World* office they had first one type-writer, and now had two. He had often done 60 words in one minute with the "Remington." As to simplicity, it took him some little time to master it, but he understood it fairly well now; and as to durability, during the five years they had had the

machines, there had been nothing serious the matter with them. He saved 20 to 25 minutes in each hour by the instrument, and though it was an expensive machine, the cost had been saved over and over again. He did not hesitate to say that in ten years' time two-thirds of correspondence and ordinary writing would be done by the type-writer. He had made a careful study of the various machines as far as he had had an opportunity, and he thought the "Remington" was the best.

Mr. RICHARDSON, referring to the "Columbia" machine, said he did not claim that its speed equalled the "Remington," but that it slightly exceeded that of ordinary writing. Its merits were that it was the smallest machine printing large and small letters; the lightest; that it printed direct from the type; and it was the only one which accurately spaced each letter, the others taking as much space for an *i* as for an *m*, also that it secured an absolute line; in all other machines there was always a tendency for the letters to jump out of the line. The price also was a great consideration, and a strong, well-made "Columbia" only cost six guineas.

Mr. STROH said he had nothing to do with the construction of the Sir Charles Wheatstone's type-writers, they were made by a Hungarian gentleman named Pickler.

Mr. J. R. WILLIAMS said he had discovered within the last few days that it was possible to take a perfect impression with the type-writer on thin gelatine, which could be placed in an optical lantern, and projected on a screen, and so enlarged as to be visible to a large audience.

Mr. HARRISON, in reply, said he was desired by Mrs. Marshall to mention one or two points which she had forgotten. She used fourteen "Remingtons" in her office at the present time, and one "Hammond." She was pleased with both machines, but gave the preference, he understood, to the "Remington," because it was more rapid. A little time ago some work was done at her office which was sent to America in a steamer which was wrecked; the mails were afterwards fished up, and though most of the writing was illegible, all this type-written manuscript, although in purple ink, the least permanent, was perfectly legible, notwithstanding it had been three or four months under water. The testimony which had been given with regard to the healthy effects produced by the use of the type-writer pointed to one of the greatest of blessings connected with it, and came, he thought, even before the three points mentioned by the Chairman. The rapidity could be tested; it was an actual fact. It was no use saying one machine could do more rapid work than another unless you could prove it. Every sensible man, before deciding such a point, would test one machine by the side of the other. Of course, a person who attempted to do writing of any kind must be educated, and the greater the variety of subjects he had to deal with, the more education he required. He had read the reports as to the permanence of the ink, because he felt that in a little time the question must come up. It would be of no use in lawyers' offices or Government departments to have documents written in ink which would fade; but the two ribbons to which he specially referred were not aniline; the base of the material was carbon, which, of course, was imperishable; and the paper for making manifold copies was also prepared with carbon.

The CHAIRMAN then proposed a vote of thanks to Mr. Harrison, which was carried unanimously.

The following machines were exhibited:—"The Remington," "The Caligraph," "The Hammond," "The Hall," "The Columbia," and "The World."

Miscellaneous.

EXHIBITIONS OF THE BELGIAN SOCIETY OF ENGINEERS.

The special exhibitions already held by the Belgian Society of Engineers and Manufacturers have been duly noticed in the *Journal.* Three exhibitions, of which the first two are international, have been organised by the society for the present year as under:—

1. Instruments and appliances for the use of engineers.

2. Processes, *matériel* and products for the reproduction, enlargement, and reduction of plans and drawings.

3. Plans, designs, and models of workmen's houses and villages, and generally of all constructions for increasing the well-being of the workman.

The first of these exhibitions will open on Friday March 2nd, and remain open about a month. It will be subdivided into five classes, as follow:—

1. Instruments and apparatus for surveying, leveling, and the plotting of plans and sections, such as rules, chains, lines, sights, staves, pedometers, squares, stadias, goniometers, sextants, levels, theodolites, tachometers, eclimeters, tablets, and photographic apparatus as applied to industrial drawings, barometers, thermometers, dials, and telescopes.

2. Drawing instruments and materials, including compasses, rules, squares, scales, T and set squares,

drawing boards and tables, pantographs, micrographs, curves and protractors.

3. Instruments for calculation, such as planimeters, calculating machines, rules, calculating circles and watches.

4. Drawing materials, including paper and cloth, pens, pencils, inks, colours, brushes, palettes, erasers and drawing pins.

5. Note-books, engineers' pocket-books, and tables for calculation.

Lectures will be given and conferences held in connection with the exhibits on Friday evenings. No charge is made for space, and tables and frames are provided; but exhibitors will be expected to subscribe to the expense of the catalogue and official report. Further particulars may be obtained from the President, 2me Comité, Société Belge des Ingénieurs et des Industriels, Palais de la Bourse, Brussels.

HAMMOCK-MAKING IN YUCATAN.

Consul Thompson, of Merida, says that from time immemorial hammocks have been articles of use and barter in Yucatan, and Yucatan at the present time exports more hammocks than any other province in the world. They are made entirely by hand, and with the aid of a few primitive yet effective implements. With a couple of straight poles, a shuttle, a thin slab of zapoli wood and a pile of heniquen leaves at hand, the native is ready to accept contracts for hammocks by the piece, dozen, or hundred. The poles are placed a certaia distance apart, according to the required length of the hammock. The thin slab of hard wood is then rapidly fashioned, with the aid of a sharp machete, into a *tonkas*, or stripper. By the aid of this instrument the fibre of the thick fleshy heniquen leaf is dexterously denuded of its envelope, and a wisp of *halch-kil*, or rasped fibre, is the result. This is then placed in a position exposed to the rays of the sun for a few hours in order to bleach it. The bleaching process having been finished, the fibres, now called *sos-kil*, are separated into a certain number, given a dexterous roll between the palm of the hand and the knees, and a long *bil-oach* or strand is produced. Two or more of these strands are then taken out, and, by a similar dexterous manipulation, converted into a *kan*, or cord. From the *kan* the hammock is made. The cord is riven rapidly around the two upright poles and the shuttle is then brought into play. This is generally the women's work, and the shuttle seems to move and seek the right mesh, says Consul Thompson, with a volition of its own, and in a very short space of time the hammock is made, and laid with its kind to await the coming of the contractor. At certain intervals the contractor gathers up the hammocks thus awaiting him, and for which he has sometimes paid for many months ahead, and takes them to Merida, where he disposes of them to the merchants who have contracted with him. The hammock makers of Yucatan are not as a class very provident, and they frequently find themselves in great straits for money, and in consideration of money advanced by the contractor, they agree to furnish him with a certain number of hammocks at a given time and price. The hammock makers are thus bound to the contractor; but the latter is generally a person of limited means, and while he must make the required advances in order to secure his stock of good hammocks, he has not the means to do so unaided. He accordingly arranges a compromise with a certain merchant or merchants, who themselves have compromises—in this case called "credits"—with some large New York firm. After reaching the hands of the merchants in Merida, the hammocks, both white and coloured, are each classified into superior or inferior grades, are neatly and compactly packed into bales, of four or five dozen to the bale, duly marked and forwarded to the United States, which country absorbs almost the entire exportation. All of the districts of Yucatan produce hammocks, but that of Tixcoco is pre-eminently the hammock district, as it produces more hammocks than all the other districts combined. Chemax hammocks are, however, noted for their fineness, and these rarely seek a buyer in the outside world, being eagerly sought for at home.

Correspondence.

MONUMENTAL USE OF BRONZE.

While in the service of the Government of Japan some years ago, I was kindly furnished, by one of its oldest officials, with what he assured me was reliable information regarding old Japanese bronze images. These are remarkably alike for their enormous proportions, the method of their construction, and the excellent character of the alloy composing them.

A very wonderful specimen known as "Daibuts" is situated about seven miles from Yokohama, and being within treaty limits, is visited by every visitor to Japan. But the largest and most remarkable bronze image in Japan is placed at Nara, some miles eastward of Kioto, or Sai Kio, as it is now named, and this has been seen but by few foreigners. An image on this site was first erected in the year 743, but it and a subsequent one were destroyed during internal wars. The present image was erected about the year 1100.

Its dimensions are as follows:—

Height of figure (sitting posture)	53·5 feet.
Length of face................	16·0 ,,
Width of face	9·5 ,,

Length of eye	3·9	feet.
Length of ears	8·5	,,
Width of shoulders	28·7	,,
Length of palm of hand	5·6	,,
,, middle finger	5·0	,,

On the head there are 966 curls. The image is surrounded by a glory, or halo, 78 ft. in diameter, on which 16 images, 8 ft. long, are cast. Two smaller images, each 25 ft. high, stand in front of the larger one.

The total weight of metal in the main figure is about 450 tons, and this is said to consist of the following:—

	Pounds avoirdupoise.
Gold	500
Tin	16,827
Mercury	1,954
Copper	986,080
	1,005,361

In considering the reliability of the above figures, it may be borne in mind that they were furnished to me by a Government official from Government records, but that, apart from the respectability of their source, I have no confirmation of them.

The large images are not cast in large pieces, but are built up with a multiplicity of small pieces of irregular shape, which are cemented together by a compound known to the natives as *handaru*, the composition of which I have not been able to discover. As illustrating the excellence of this cement, I have closely examined this large image, and could not discover any softening or signs of decay at the joints. Further, the cement has taken on the same tarnish as the bronze, and the joints are therefore not observable except on close inspection.

The images are in the form of Buddhist deities, and from whatever point of view they may be regarded, whether artistic or merely mechanical, they are interesting examples of isolated and early skill.

R. HENRY BRUNTON, M.Inst.C.E.

162, Norwood-road,
West Norwood, S.E.

SANITATION IN INDIA.

I should be the last to dispute the very great authority of my friend, Mr. E. Chadwick, on matters of sanitation, but one point I would like to notice in his letter in your last issue. What has always seemed to me to militate against the exactness of sanitary science is that anyone should have lived in Calcutta in unsanitised days. Yet many people did live. The extraordinary low death-rate in the European Orphanage situated not only in Calcutta, but in the ill-famed suburban quarter, is not recent. From the beginning of the present century downwards there has been a most astonishingly low mortality in that institution.

I, myself, lived for years in Calcutta with my children nearly a quarter of a century ago, before there was water supply, drainage, or anything else. We got on fairly well, my children gave no serious trouble, whereas from the moment we came home we lived the lives of hunted hares, being continually afflicted with juvenile epidemics of all kinds.

It has yet to be shown that modern measures have been successful in Calcutta. Certainly, cholera has not been abolished either in Calcutta generally or in any part of it. I sincerely wish it were.

GEORGE CAMPBELL.

Feb. 14th, 1888.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 22.—"The Technical Education Bill." By SWIRE SMITH. Prof. SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FEBRUARY 29.—Discussion on Mr. SWIRE SMITH'S paper, "The Technical Education Bill."

MARCH 7.—"Framework Knitting." By W. T. ROWLETT.

MARCH 14.—"Technical Instruction in Agriculture." Prof. JOHN WRIGHTSON.

MARCH 21.—"The Evils of Canal Irrigation in India, and their Prevention." By T. H. THORNTON, C.S.I., D.C.L.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 6.—"South African Gold Fields." By W. H. PENNING, F.G.S.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

FEBRUARY 24.—"Facts regarding the religions of India, and their influences on the social progress of the people." By SIR WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D. The EARL OF NORTHBROOK, G.C.S.I., will preside.

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

CANTOR LECTURES.

The Second Course is on "Yeast, its

Morphology and Culture." By A. GORDON SALAMON, F.I.C., F.C.S. Four Lectures.

LECTURE IV.— FEBRUARY 20.— Pure yeast in the brewery.—Apparatus employed in its production upon the large scale.—Method of manipulation.—Results achieved.—Is the method available in high fermentations?—What advantages might it produce? —The products resulting from yeast growth.—Fermentation. — Historical retrospect. — The various theories.—To what extent are they reconcilable?—What practical advantages have been derived by their enunciation?

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. Gordon Salamon, "Yeast, its Morphology and Culture." (Lecture IV.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. B. McArthur, "The Bromine Absorption of Mineral Oils. 2. Mr. Kingzett, "Note on Camphor Oil and Oil of Sunflower." 3. Mr. A. G. Green, "A New Series of Cotton Colouring Matters." 4. Prof. Mendola, and Mr. E. H. Moritz, "Note on Kjeldahl's Method of Nitrogen Determination."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. L. Harvey, "Masonry and Architectural Students."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. Boscowen, "Babylonian Civilisation."

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. H. C. Shuttleworth, "Contemporary Novelists."

TUESDAY, FEB. 21...Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion on Mr. Josiah Pierce's (jun.) paper, "The Economic Use of the Plane-Table in Topographical Surveying." 2. Mr. R. A. Hadfield, "Manganese in its Application to Metallurgy," and "Some Novel Properties of Iron and Manganese."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. J. G. Colmer, "Some Canadian Railway and Commercial Statistics."

Pathological, 53, Berners-street, Oxford-street, W. 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Prof. G. B. Howes, "The Azygos Vein of the Anurous Amphibia." 2. Mr. A. Smith - Woodward, "Palæontological Contributions to Selachian Morphology." 3. Mr. Oldfield Thomas, "List of Mammals obtained by Mr. G. F. Gaumer on Cozumel and Ruatan Islands, Gulf of Honduras."

Colonial Inst., Northumberland-avenus, W.C., 4 p.m. Annual Meeting.

WEDNESDAY, FEB. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Swire Smith, "The Technical Education Bill."

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, FEB. 23...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Carl Armbruster, "Historical Development of Music from Bach to Lizst."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert H. Parry, "Early Secular Choral Music." With illustrations. (Lecture III.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. R. von Fischer Treuenfeld, "The Present State of Fire Telegraphy."

FRIDAY, FEB. 24 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Sir William W. Hunter, "Facts regarding the Religions of India, and their Influences on the Social Progress of the People."

United Service Inst., Whitehall-yard, 3 p m. Colonel Sir Charles Nugent, "How to Secure our Coast Line generally against Sudden Attack, with the means of defence at present available, or with such means as might be made available at a few weeks' notice."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p m. Very Rev. G. Granville Bradley, "Westminster Abbey."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Arthur J. Knowles, "The Erection of the Superstructure of the Forth Bridge."

Quekett Microscopical Club, University College, W.C., 8 p.m. Annual General Meeting. Presidential Address.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Paper by Mr. H. G. Henderson.

SATURDAY, FEB. 25...Sanitary Assurance Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m. Annual General Meeting.

Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. W. E. Ayrton and Mr. John Perry, "Note on the Efficiency of Incandescent Lamps with Direct and Alternate Currents." 2. Hon. Ralph Abercrombie, "Observations on the Height and Length of Ocean Waves." 3. Mr. W. W. Haldane Gee, "Experiments on Electrolysis." 4. Mr. Herbert Tomlinson, "The Temperature at which Nickel begins suddenly to lose its Magnetic Properties."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture VI.)

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FRIDAY, FEBRUARY 24, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

Committee.—Sir Douglas Galton, K.C.B., F.R.S. (Chairman of the Council), Sir Frederick Bramwell, D.C.L., F.R.S., W. H. Barlow, F.R.S., E. C. Robins, F.S.A., Col. A. E. Hamilton, R.E.

A conference will be held on this subject, by the Society of Arts, on Thursday, Friday, and Saturday, May 10th, 11th, and 12th, 1888. The following, amongst others, are subjects on which suitable papers will be received:—

1. History of the rise and progress of canal and inland river navigation in Great Britain and Ireland.

2. Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c.

3. The canals of other countries.

4. Present condition of canal navigation in Great Britain and Ireland. Suggestions for its improvement.

5. Canals and railways—their mutual influence on each other.

6. Comparative cost of transport by railways and by canals. Tariffs.

7. The law of canals, and matters relating thereto.

EXAMINATIONS, 1888.

The attention of secretaries of examination committees is drawn to the fact that the Society's Examinations, with the exception of that for Practical Music, will be held on the evenings of Monday, 9th April, Tuesday, 10th April, Wednesday, 11th April, and Thursday, 12th April. Committees having candidates for examination must apply, on or before the 1st March, to the Secretary of the Society of Arts for a form whereon to make their application for examination papers. These forms must be returned not later than 12th March. Candidates desirous of being examined should apply to the secretary of any Institution in union with the Society, or to the Secretary of one of the Examination Committees. Programmes of the Examinations, with lists of the Committees, can be obtained on application to the Secretary of the Society of Arts, John-street, Adelphi.

CANTOR LECTURES.

The fourth and last lecture of the course on "Yeast, its morphology and culture," was delivered by Mr. A. Gordon Salamon, F.I.C., F.C.S., on Monday evening, 20th inst. The lecture was illustrated by a series of objects shown in a large number of microscopes lent by Messrs. R. and J. Beck, of Cornhill.

A vote of thanks was passed to the lecturer on the motion of the Chairman (Colonel A. C. Hamilton, R.E.).

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 14, 1888; Sir George Birdwood, K.C.I.E., C.S.I., M.D., LLD., in the chair.

The paper read was—

THE PRINCIPLES OF DESIGN AS APPLIED TO BOOKBINDING.

By Henry B. Wheatley, F.S.A.

In submitting to the Applied Art Section a paper on the development of modern bookbinding, I fear that it may be thought that I have chosen a somewhat too ambitious title; but the title expresses what I wish to discuss, and as the subject is fairly fresh, I hope you will extend to me your indulgence, and will excuse the inadequacy of my treatment of a very interesting subject.

So much magnificent work has been produced, that there is a strong inducement for the binder to imitate this work, but we know that a living art cannot be one of imitation only. New ideas must be adopted, and the old motives must be reconsidered, and adapted to

the new, if the art is to be of vigorous growth, and to become essentially modern, or a living art.

In its best days bookbinding was one of the applied arts, which influenced the others, and was influenced by them. This is not so now; it is an art apart, and those who understand it are but few. It is not the philistine only who cannot appreciate the beauty of good binding, for many an artistic nature is unable to understand the motives of the binder, by reason of ignorance of his methods. To illustrate this, I may point out that the special growth of the æsthetic sentiment during the last few years has had but little influence upon the art of bookbinding. Such growth of a taste for good binding as exists is almost entirely owing to the public sales of fine libraries, by means of which so many beautiful specimens have been brought under the public eye.

I do not propose in the present paper to accumulate archæological details, but my object is rather to refer to the past as a storehouse of ideas for use in the future. At the outset it may be well to answer the question, what has the binder to bind? He has old books to repair or rebind, and new books to bind for the first time. With respect to the first, he requires a knowledge of the various styles of the past, so that he may put the book into a covering appropriate to its date, and, I would add, its language. It is not satisfactory to see an English book, on an English subject, elaborately tooled with nothing but *fleurs de lis*. The French have done so much in illustration of the history of binding, that all those who obtain their knowledge from a French source are too apt to ignore the very existence of good old English binding. In fact, the general ignorance of the history of English binding among Englishmen, as well as among foreigners, is very great. Mr. Weale, respecting whose remarkable researches into the history of early bindings I shall speak later on, is inclined, I believe, to place the position of the English artist of the 12th and 13th centuries very high indeed. He considers that his work not only will bear comparison with the work of any country of Europe, but that it is superior to contemporary work abroad. The same conventual establishment which turned out some of the most exquisitely written and illustrated missals and service books of the Middle Ages also produced the most beautiful bindings.

We have, therefore, plenty of material to hand which may be studied, and adapted to our present needs. With new books the style should be new and fresh. It is surely a waste of time to copy elaborately a design of the 16th century on the cover of a book published this year, unless, of course, the design may be appropriate to the subject of the book. In considering a design on paper, and its fitness for reproduction on the cover of a book, we have several points to consider. Thus, the shape of a book, the material used for binding, and the colour of the leather, are matters of the greatest importance.

As to materials, calf, morocco, and vellum, from their difference of surface, seem to indicate difference of treatment; and as to colour, many a design has been spoilt by the want of harmony in the colours used to carry it out. In the old work there is a mellowness in the colour of the leather and the gold which often gives a charm to very ordinary work, so that we overlook incongruities of style while admiring the glories of tone.

In this paper I do not propose to deal with the early bindings of manuscripts and printed books in velvet, metal, and embroidery. These styles may be studied with advantage by those who have to bind special objects in book form, but on the present occasion the consideration of the treatment of leather and cloth will fully occupy our time. I propose to treat my subject under the three headings of (1) Blind Tooling, or mediæval work; (2) Gold Tooling, or the work of the Renaissance; and (3) Cloth Binding, or modern work.

I.—Blind Tooling.

Mr. Weale, as the result of long continued researches among the cathedral and conventual libraries of Europe, tells us that for the genesis of design on leather we must go much farther back than the time of the invention of printing; and he has made most important discoveries, the results of which we shall all look forward to be informed of, and I hope it will not be long before his work on this subject is published, with a full selection of reproductions of the magnificent series of rubbings which he has collected. Mr. Weale finds three schools of English binding in the 12th and 13th centuries, viz., that of Durham, of Winchester, and of London. I will not enter into this point further, as it is for Mr. Weale to explain the results of his own researches, but I only mention it here as a remarkable revelation of the perfection to which leather binding had arrived so early as the 12th century. This revelation we owe entirely to Mr. Weale.

In spite, however, of this early perfection,

we may broadly say that when the early printers began to issue their works in a leather covering, they began afresh to build up their designs. This, however, was not so much the case in Germany as in England, for in the former country the printers made more use of the old models than they did in England. It is necessary to remember that in the case of the work of the monasteries, most of the beautiful binding to which reference has been made was worked in single

FIG. 1.—BINDING OF JULIAN NOTARY.

copies, bound for the library of the convent, with its stamp on the cover, while the coverings of the works issued by the early printers were produced wholesale, much in the same way as the cloth bindings are now-a-days.

The earliest printed books in England were issued in leather covers, with a few diagonal marks upon them; for instance, most of the bindings of Caxton are of a very coarse and crude character. Then stamps were produced, often very elegant in design, but these were surrounded by very indifferent tooling. The blocks were usually small, and on a small book one would be placed on the front side and the other on the end side, but when the side of the book was of sufficient size both would be placed on the one side. I have here an instance of this, taken from a book in the library of the British Museum, by the celebrated painter, Julian Notary, with his initials and stamp (Fig. 1). Here the two blocks are on one side, and while the blocks are beautifully bright and well cut, the tooling is very careless and irregular. Pynson used French tools in his bindings, but the bindings of Wynkin de Worde were better in themselves, and more distinctly English in character. The building up of blocks, with connecting designs of the artist, is to be found in all old blind work, but it is marked in its crudest form in the books of the English printers.

Among bindings of the early printers, German art was greatly in advance of ours. While our printers were turning out books in a somewhat uncouth style, the Germans and Dutch were issuing theirs covered with excellent designs. There is no reason why many of the designs which are worked in gold should not also be worked in blind, but as a rule this is not the case. It is, therefore, I think, fair to distinguish blind tooling as the style of the Middle Ages. It is not suited, as a rule, to the books of to-day. It can, however, be adapted with advantage for the binding of old books, or books connected with mediæval times. I have here an instance of this in a copy of Loftie's "Latin Year," lent by Sir George Birdwood.

II.—GOLD TOOLING.

When we come to trace the origin of gold tooling, we are met with a very great difficulty. I believe that it is totally distinct in its origin from blind tooling, but there are instances in which the two have been found together. Thus, the gold tooling, as we have it now, came into being at the end of the 15th century, yet gold and blind have been found together at a much earlier period; and Mr. Weale has discovered a very early instance of inlayed leather binding, with gilt rings of metal over the edge of the inlay. This specimen is dated about 1367. There is thus the same difficulty in drawing the exact line of distinction between blind tooling and gold tooling, that there is in showing where animal life ends and plant life begins, but as an ordinary plant and an ordinary animal are sufficiently distinct,

so there is little difficulty in tracing the totally distinct motives of blind and gold tooling—they really have nothing in common. Gold tooling is evidently the child of the Renaissance, and I believe that we owe it to the Italians, who obtained it from the East. I know that in stating this view thus broadly I am running counter to Mr. Weale's views, and considering the scientific manner in which that gentleman has worked, and the mass of material which he possesses to back up his opinion, I challenge his view with some diffidence. I understand Mr. Weale to contend that gold tooling is of German origin, for although the first known specimen of this work was produced at Rome in the middle of the second half of the 15th century, it was the work of a German printer, and the second known specimen was produced at Augsburg. There is thus much to be said for Mr. Weale's view, but I cannot believe that this truly Renaissance art came from the country which continued longest the mediæval methods, and it seems but natural that the art should have been born in the land of the Renaissance. The sequence of historical bindings can be traced to Italy, and through Maioli and Grolier to France, which has been the scene of the chief triumphs of the art.

In almost all kinds of binding we may find traces of design which appears to have come from the East, but in the older gilt tooling we often come upon designs which are almost entirely Oriental in character. That thick gilt centre, so common in gold toolings of all periods, is identical with what is to be found on Persian books, and it still is to be seen on English bindings of to-day. Sir George Birdwood exhibits two blank books, in elaborately tooled leather, such as are sold in India for about a rupee a piece, which are of great interest, as showing the connection of European gold tooling with Eastern design.

When we come to trace the sequence of styles which have held sway in the art of gold tooling, we shall find that the first general pattern was the purely geometrical, as seen in the books of Maioli and Grolier. It is a question worthy of investigation whether this design, which spread over Europe in a very remarkable manner at the end of the 15th and beginning of the 16th century, was imitated from the books of Maioli and Grolier, or whether these collectors adopted it because it was the fashion. Whatever its origin may be, this geometrical pattern will always continue to be known by the name of Grolier.

The next step was to fill up the vacant spaces left between the lines of the geometrical pattern, and this was done by means of floral decoration. The two chief forms of this decoration are the branch and the scroll. This singularly beautiful style is now thoroughly associated with the name of Clovis Eve, royal binder to Henri IV. and Louis XIII., who also bound for De Thou. It is, I think, an interesting illustration of the intercommunication of the domestic arts that the scroll just referred to is to be found on an old Damascus plate now at the South Kensington Museum (Fig. 2, p. 363). This can be compared with a portion of a fine binding by Clovis Eve, in which the scroll appears (Fig. 3, p. 363).

The next departure was the elaborate geometrical design without floral decoration which is associated with the name of Le Gascon. This is a name to conjure with, and it is often given to designs quite unlike those now referred to; and a curious instance of this misappropriation was seen in the catalogue of the library of the late Mr. Bedford. Here books bound by Bedford in the pure old English cottage style were described as after Le Gascon. Nothing is known of the history of this binder, and M. Leon Gruel, in his beautiful work "Manuel Historique et Bibliographique de l'Amateur de Reliures," even expresses a doubt of the existence of such a binder.* M. Gruel gives some splendid specimens in this style, bound about 1640 by Florimond Badier, which have been attributed to Le Gascon, and thinks it possible that Le Gascon is merely a surname for Badier, or some other binder of the time.

Besides these designs, a simpler, but equally effective one, was obtained by the repetition of initials, emblems, badges, and other personal ornaments, such as the F and *fleurs de lis* of Francis I., the H and D and interlaced crescents of Henri II. and Diana of Poitiers, the C of Charles IX, the lilies of Margaret of Valois, the H and *fleurs de lis* of Henri IV., the M of Marie de Medicis, and the L of Louis XIII., and the monogram of L and A, of Louis and his wife Anne of Austria.

With the eighteenth century came in the elaborate inlaid work of Le Monnier and others, but in this same century we see but little of a fully covered side, and the De Romes adopted borders and corners, with arms in the

* M. Gruel's work, which contains some of the finest reproductions of odd bindings ever made, has been kindly lent by the author for exhibition.

centre, and a considerable amount of plain leather left untooled.

Then we have the weak lace borders of Padeloup, and after this binder comes darkness. There can be no doubt that the finest specimens of historical gold toolings

FIG. 2.

EARLY DAMASCUS PLATE IN THE SOUTH KENSINGTON MUSEUM.*

FIG. 3.

PORTION OF BINDING BY CLOVIS EVE.

were produced in France, and it is, therefore, convenient to choose the examples of eras in design from French bindings, but we must not forget that England produced some splendid specimens of the art, which followed the same lines as the French, but which were by no means servile copies of the productions of our neighbours. James I. was apparently the most tasteful patron of bookbinding among our sovereigns, and the British Museum Library contains a magnificent collection of his books, bound in the most sumptuous manner. Many are large folios covered with heraldic thistles, which have a very fine effect. Fig. 4 is taken from one of these handsome volumes, and this portion of the side shows the repetition of the thistle and *fleurs de lis*.

The books produced by Nicholas Ferrar and the so-called Nuns of Little Gidding, are chiefly known as examples of embroidery, but in some instances this embroidery has been lost, and the tooled leather binding, which was under an embroidery, only remains.

* This block has been kindly lent by the Science and Art Department.

Fig. 5 is a greatly reduced copy of one of these, being the "Harmony of the Four Evangelists," in the British Museum.

The works of a later date show the influence of the styles of art which succeeded each other, and left their mark in our houses and on our books. There is in the Exhibition a specimen of design in which the influence of Chippendale is seen on the side, and that of the Adams on the back. The Cottage and the Harleian styles, among others, are distinctly English,

FIG. 4.

PORTION OF BINDING FOR JAMES I.

and unlike the styles adopted in other countries. Fig. 6 (p. 365) represents a volume of a magnificently tooled folio Bible of the end of the 17th century.

Roger Payne is the artist whose name is best known among those of English bookbinders, but much of his binding is singularly plain. Fig. 7 (p. 366) represents a very fine specimen of his work in the British Museum. The border is very elegant, but the side of this volume has been somewhat spoilt by the coat of arms of Mr. Grenville, which, with much bad taste, has been stamped upon it.

The capabilities of modern binding are endless, and I am happy to see a strong tendency to break away from the fetters which have too much environed the art. There is no need to follow servilely in the path marked out in the past. The French binders of to-day have realised this fact, and in two books published by M. Edouard Rouveyre,* "La Relieur Moderne, Artistique, et Fantaisiste, par Octave Uzanne" and "La Reliure de Luxe, par L Derôme," contain some beautiful specimens of what may be accomplished with aid of good taste in the modernisation of bookbinding design. Perrault's "Fairy Tales" has Puss in Boots delineated in mosaic on the side. Victor Hugo's "Notre Dame de Paris" is ornamented with an architectural design, and "Paul and Virginia" has on its side two birds billing and cooing on a branch.

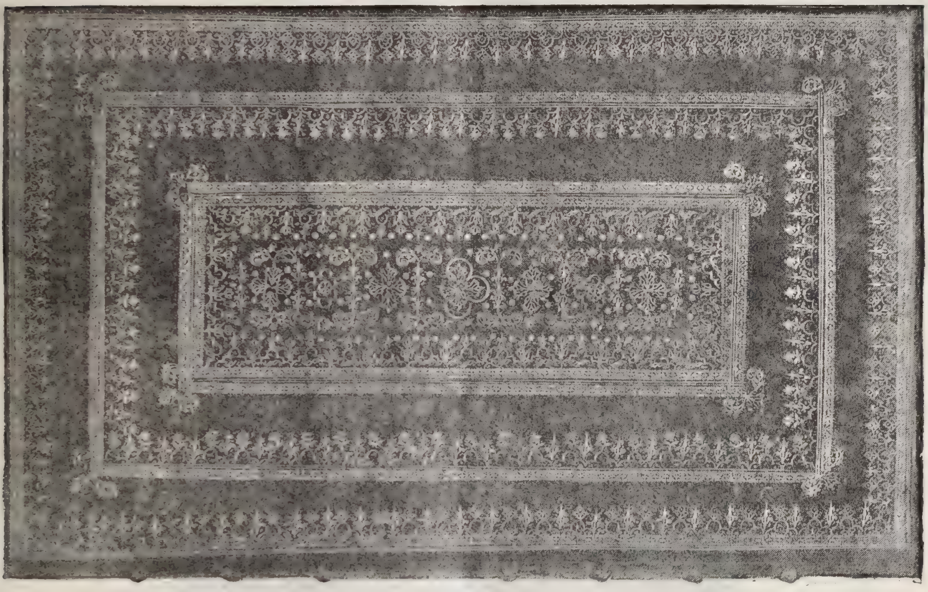
There is another difficulty in the way of a modern binder, and that is that much which would be praised in an old book would be condemned in a modern one. Such is the power of age to silence criticism. Much of the ornament that can be suggested would be ordinarily conventionalised, or it would be treated in a specially heraldic manner, which is one of the most appropriate for a book. There is, however, no reason why the natural should not be used as well as the conventional, so that the two are not mixed. If the side of a book is left plain, a natural flower or spray may be tooled or painted upon it, so as to appear as if it had been thrown down carelessly.

This point naturally leads us to consider the materials used for bookbinding. Calf was often used by the old binders as a medium for elaborate ornamentation, but this leather, as prepared at present, is so fragile that it is seldom so used now. Tree-marbled calf is effective, and continues to hold the high position which it always has held in public esteem. The beautiful surface of calf fits it for flat treatment, and much may be done with painted designs. Sometimes ornaments have been printed in black on the natural coloured calf.

Vellum is a material as beautiful as it is strong, but it must be used with care, and kept at a distance from the fire. This also takes a painted design well, but gilt tooling is also effective in contrast to its brilliant white colour.

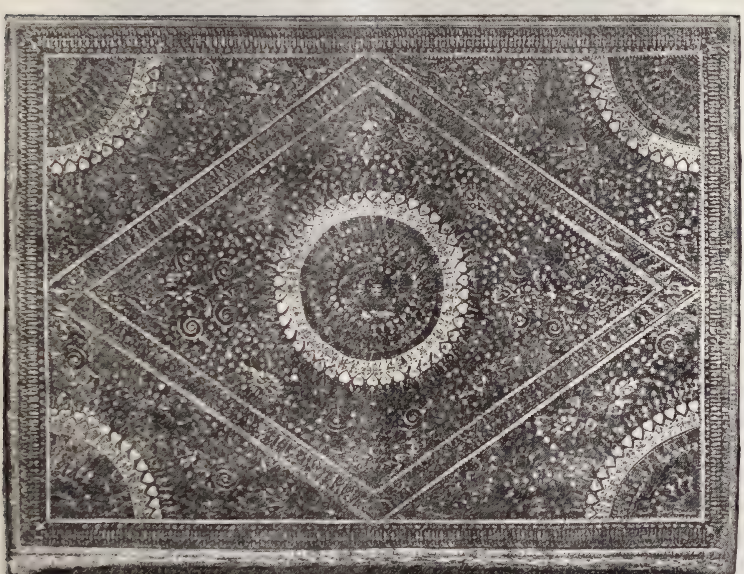
* Mons. Rouveyre has also just issued a beautiful work on the art bindings in the National Library, Paris. All these works, kindly sent by M. Rouveyre, were shown in the Exhibition.

Fig. 6.



English Binding of 17th Century.

Fig. 5



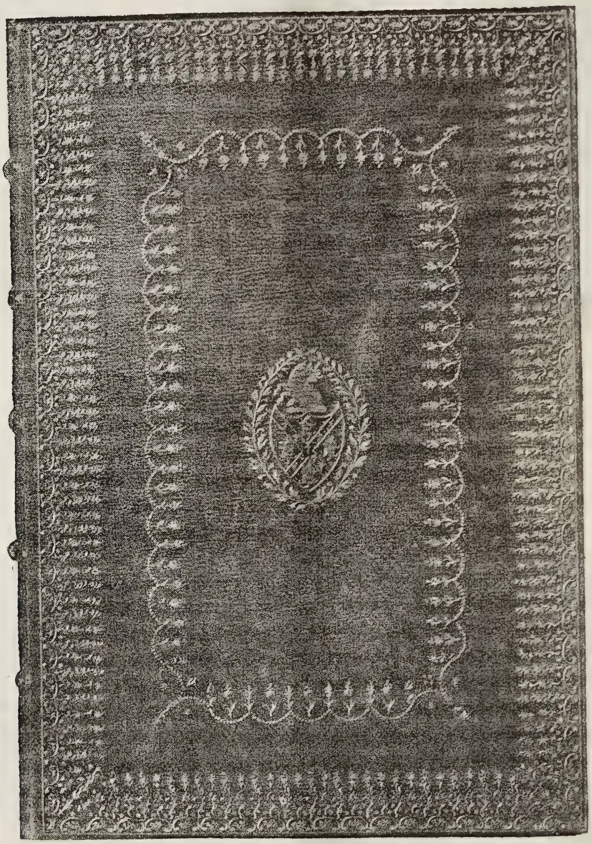
Little Gidding Binding.

Morocco will always remain the main material for bookbinding; its durability is so remarkable that no other leather is likely to oust it from its pre-eminent position, and its variety is very considerable, as it may either be used rough or smooth as required, and its dyes are fairly permanent, and very different from the evanescent dyes of calf. Sir George Birdwood exhibits a pair of slippers, with a pattern cut out in the leather in a manner which might be adapted to bookbinding, and would be a novelty.

This is not a paper on bookbinding in general, but on design as applied to the binding of a book. I am, therefore, precluded from treating of forwarding, end-papers, half-binding, and sundry other matters which come under the heading of bookbinding.

Mention may be made in this place of some of the vagaries of binding. I have seen a little book with a beautiful cameo portrait of the authoress on the end cover, and emeralds set in the clasp. Ivory carvings have been let into the covers, and many of these eccentricities are allowable as long as they remain the exception, and do not claim to be the rule. Embroidery has lately been revived with so much success that it seems well again to adapt it to bookbinding, as was done in the sixteenth century. The School of Art Needlework at South Kensington have done this in a few instances.

Fig. 7.



Binding by Roger Payne.

Cloth Binding.

The history of cloth binding ought to be one of great interest to us, as it is entirely of English growth (the French call it *la toile Anglaise*, and the Germans, *Englisches einband*), and its introduction is comparatively so recent that we are able to trace the

sequence of the various changes that this special form of binding has gone through. Books at the beginning of the present century were usually issued in paper boards, of various colours, with white paper labels, upon which the title of the book was printed. This was by no means a bad binding, but after a little use the paper was apt to crack at the hinge, so that the side got disconnected from the back. About 1822 a remedy for this was suggested, by covering the back with calico or cloth. This may be illustrated by a set of the old library edition of Scott's "Waverley Novels," in octavo. The "Novels and Tales," 12 vols., were issued in 1819, in pink paper, with white paper labels. The "Historical Romances," 6 vols., appeared in 1822, in blue paper, with pink cloth back, and white paper labels; and the "Novels and Romances," in 1824, in the same covering.

The late Mr. Archibald Leighton may be called the father of cloth binding, as to him the earliest specimens of this book covering have been traced. According to an interesting article on Mr. Leighton, in the *Bookbinder* (No. 7), the first book published in the new material was the first volume of "Pickering's Miniature Classics" (Dante), which appeared in 1822, and probably the second book so issued was Moule's *Bibliotheca Heraldica*.

The earliest cloth bindings were supplied with a printed white paper label, but after a time gilt letters were stamped upon black paper labels. Then the great advance was made of stamping the title in gold letters direct upon the back of the book. The edition of Lord Byron's "Life and Works," published by Murray, in 1832, has the distinction of showing very clearly the period when this change was made. The first volume was issued in January, 1832, and was bound in cloth with a watered silk pattern, and on the back was a green paper label, with the title and a coronet printed on it in gold. The second volume appeared in February of the same year, with the title and coronet stamped in gold direct upon the cloth.

Mr. Henry G. Bohn, writing to the *Art Journal* some time back, said that, through some hints given by him to Mr. Leighton, that gentleman was able to bind Martin and Westall's Bible Prints for him with the lettering direct upon the cloth of the back, by which means these volumes were bound at half the price he would have had to pay if leather lettering pieces had been added. This book was published in 1832.

Archibald Leighton made a great advance when he produced the stamped cloth which was used for the "Penny Cyclopœdia" and the "Pictorial History of England," published by Charles Knight. The octavo edition of Dickens's "Sketches by Boz," with Cruikshanks' plates (1839), was bound in cloth, with square tablets on the back, and a flowing design on the side. This was the work of Archibald Leighton, who died in January, 1841. Although cloth binding was introduced in 1822, it was several years before the old paper boards were at all generally discontinued.

Not long before the lamented death of Mr. Henry Bradshaw, the late Librarian of the University Library, Cambridge, I went over the shelves of his private library with him, in order to settle some of the dates connected with the history of cloth binding, a subject in which he was interested, and we made a special investigation of his very valuable collection of early editions of Lord Tennyson's works, with the following results. The "Poems of Two Brothers," (1827), was in grey paper boards with paper labels. The "Poems, chiefly Lyrical," (1830), in the same covering, and another copy with blue paper sides and grey paper back. The "Poems," (1833), were in grey paper boards, and the "Poems," (2 vols., 1842), in the same binding. Mr. Bradshaw possessed two copies of the "Poems," (2 vols., 1845), which were differently bound. One was in plain green cloth with paper labels, and the other in stamped cloth with gilt lettering. These two being both of the same date, it would have been difficult to prove the priority of either, if it had not been that the one with paper labels contained some advertisements dated August, 1845, while the advertisements of the stamped cloth copy were dated January, 1846, proving that this had been bound at a later date.

The next great departure in cloth binding was the use of gold in the ornamentation, and some difficulty was found at first in designing for the gold. Till the theory was understood, an ordinary drawing, made upon white paper, was apt to come out wrong when the dark lines were transferred to gold, which is, ordinarily, lighter than the cloth upon which it is placed. To get the proper effect, the design should be drawn upon a slate, when the light lines show on the dark ground. Many specimens of bad outline and bad shading may be seen among the early gilded cloth bindings. The original cloth covers of Mr. Ruskin's works are of interest from an artistic point of view. The

best edition of the "Modern Painters" (1851) is bound in green cloth, with a very poor design in blind and gold. The "Seven Lamps of Architecture" (1849) has a very original and excellent design in blind, while "The Stones of Venice" (1853) has good design in blind and gold; the treatment of the winged lion in gold on the back is not, however, altogether satisfactory. Among the most charming and appropriate cloth covers I know, are those used for Mrs. Jameson's artistic works. The "Legends of the Madonna," with its grey tint, and the union of blind and gold, is very pleasing. The "Legends of the Monastic Orders" (1850) is equally good in design, but the colour of the cloth is not so satisfactory. These are by Mr. John Leighton. After a time the gilt decoration of cloth became so excessive that in due course good taste revolted against this abuse, and books were very plainly clothed, with little or no ornament. The plain cloth, with its bevelled edges and plain gold line, and possibly the title in gold on the side as well as the back, has a good effect, but there is no reason why this style should be universally adopted. There is room for a more ornate style. Some of developments of cloth binding are not to be commended, and some of the coloured pictures on the sides of books are anything but pleasing. Some of the finest specimens of modern cloth binding are due to Mr. William Morris, to whom art owes so much. Mrs. Orrinsmith's design for Lord Tennyson's works is good. If publishers will only employ good artists we should do well, but, unfortunately, this is not always the case.*

It is, perhaps, necessary to mention that cloth bindings are here discussed because this is a paper on design, but, of course, the mode of treatment is quite different from that adopted in regular binding. It must be borne in mind that in the case of leather binding the design is transferred to the leather by means of a series of distinct tools, while the cloth covers are produced wholesale by means of a stamp.

The French have very cordially acknowledged the admirable qualities of the English cloth binding, and of late years they have adopted it themselves. I think we can discover in the French work that the grand specimens of gilt leather bindings have had a greater influence upon the designer than they have in England. It is rather curious that while the characteristic of French leather binding is great lightness, the cloth binding in France is decidedly heavier than in England. It has, however, many points of merit.

In tracing the history of cloth binding, we find first the use of plain cloth either entirely covering the boards or only over the back, with a paper label and sometimes a leather lettering piece. Then we find the lettering in gold placed direct on the back; then stamped cloth in blind was adopted; and last of all we have the designs worked up in gold. Sometimes the cloth is stamped in colours with a design, and the variety of treatment which may be adopted is very great.

In considering what styles may best be adopted in cloth binding, we may well start with the dictum that designs suitable for leather are not necessarily suitable for cloth, and the reverse is also true.

In summing up the results of our consideration of this subject, I would say that in respect to cloth binding, the author or editor of a book of importance should insist that an artist be employed to design a cover. We have seen that some of our best artists will do this work, and if they are more generally employed we may rest assured that a large number of beautiful designs will be brought into our homes, and thus help to cultivate our taste.

The main principles of design suitable for bookbinding are almost self-evident to those who have considered the subject, but it may be well to formulate them roughly here. First and foremost is appropriateness of design, and this may be considered in respect (1) to the age of the book, and (2) the subject of the book. Concerning an old book, it will be well to bind it as nearly as possible in the style of the period when it was published, and with early printed books and works on subjects connected with the Middle Ages, blind tooling will often be found to be the most suitable style. It is clear that some subjects, such, for instance, as political economy, are antagonistic to a very ornate treatment. Natural history is different, and there are many beautifully illustrated works in this department which deserve a handsome binding. Books in botany will be easily treated with a floral design, which should be made to grow from a stem. Zoology will be illustrated with more

* In dealing with commercial bindings, of which those in cloth are the general rule, it seems unfair to leave unmentioned printed boards, in which some very successful covers have been produced, such as Mr. Walter Crane's "Baby's Opera," and, at a much earlier period, Leigh Hunt's "Jar of Honey from Mount Hybla" (1848). The great objection to these boards was the old one, that they so easily cracked. This has been got over by adding cloth to the back in order to give the necessary strength.

difficulty. The valuable old books of travel, such as Hackluyt's "Voyages," Purchas's "Pilgrims," Mandeville's "Travels," and Smith's "Virginia," will give scope for the ingenuity of the designer, and the designs may allowably be somewhat quaint and *outré*. Poetry, and works of imagination generally, seem specially marked out as suited for elaborate and imaginative designs.

Merely to mention some of our great authors, Chaucer's works might be covered with flowers, as appropriate to the great poet of nature; Spencer should have the lion, spears, and knightly emblems; Shakespeare's spear might be adapted with good effect, and the sides might be covered with it and repetitions of W. S.

There would be some difficulty in binding all our authors in an appropriate style, but this is a point well worthy of being thought out. The illustrative ornament should be clear to all, for the great fault of a style too emblematical is that it requires explanation, otherwise the uninitiated will not understand it.

Instead of illustrating the contents of the book, the design may be made to denote the ownership; in fact, it has been universally conceded that marks of ownership should play an important part in binding design.

It is of paramount importance that designs should be adapted to the size and form of the book. The shape is, of course, rectangular: this may be accentuated by horizontal and perpendicular lines, or it may be made less remarkable by a flowing treatment, but a design intended for a round object will not be suitable for the side of a book, unless it is greatly modified.

Then there are the various parts — the back, the sides, and the leaves. When there are bands on the back, the style of ornament is pretty rigidly marked out; there must either be a repetition or alternation of design in the different panels, and the style of ornament does not admit of much originality of treatment, as there are certain rules which it seems necessary to obey. When, however, the back is flat, and no bands are used, there is much more scope for beauty of design, but it is astonishing how little attention has been paid to the back by the great binders. The backs of the Marguerite de Valois books are beautiful, and so are many of De Thou's volumes, but usually the treatment of the back is particularly weak. One of the most beautiful backs I have seen upon a modern book is that on the copy of "The Germ" bound by Mr. Cobden Sanderson. Here there is a flowing branch running up the back; this is cut off by the open space occupied by the lettering, but Mr. Sanderson, by a happy inspiration, has connected the separated portions of the branch by means of a tendril running through the lettering. Sometimes the back has been treated with success in connection with the sides, and a consistent whole has thus been obtained.

In treating the side we may either cover it entirely with a design, or arrange corners and centre with a certain amount of plain leather left to view. These corners and centre may be kept unconnected, or they may be united by a floral or geometric design. It is worthy of note in respect to these corners, that an ornament should not be used when in two of the corners it has to be placed upside down. This is unpleasing to the eye. An instance occurs to me in regard to the books of Henry, Prince of Wales. In some of these there are roses in the corners, and these look well, but the crowns in the upper corners look as if they ought to fall off, and this objection applies with especial force to those cases where the Prince of Wales's feathers are used. In the most elaborate bindings the edges are now frequently left uncut, and the top edges only gilt, but this has a somewhat unfinished look, although it saves the book from being reduced in height and width. Gauffred edges have a good effect, and colour under the gold is almost always an improvement.

With respect to the interior of the book, we may say that an elaborately bound book should always be lined with leather at the hinge, so that the unpleasant effect of the abrupt stopping of the extra leather next to the book may no longer be seen.

Simplicity is not to be always aimed at in design, but it often has a special charm, as when a special ornament is repeated over the whole side, instead of the bewildering perplexity which is sometimes aimed at. Some of the most beautiful specimens of historical bindings are instances of this principle of repetition.

Designs should certainly not be too pictorial in character, and portraits on the side of a book are not often successful.

Bearing in mind the three chief points of age, subject, and form, the binder may range the world in search of designs, and may appropriate them with a free hand, thus many designs of a square or oblong character, such

as grilles, panels, &c., may be adapted to the sides of a book.

The expense of an elaborately tooled book must naturally be great, and until the public are educated sufficiently to understand this, the difficulties of the artist book-binder will be great. If, as it may easily do, a specially fine piece of binding occupies a skilled workman a whole year, it stands to reason that the cost must run into three figures. I scarcely like to bring this commercial point too prominently forward, but I feel very strongly that until the English realise that a really artistic binding must, like other artistic objects, be costly because it represents the brains and labour of highly skilled men, we shall continue to be outstripped by the French, whose public do realise this fact. I see no reason why, if sufficient patronage was extended to the art, English bookbinders should not equal the French in every way.

The paper was illustrated by a series of lantern slides, representing a sequence of historical bindings, and also specimens of Messrs. Riviere's and Mr. Zaehnsdorf's bindings.

Mr. Weale exhibited at the meeting some of the rubbings of early bindings, which he is now arranging and cataloguing for the Science and Art Department, South Kensington.

DISCUSSION.

Mr. WEALE said that, with the permission of Sir Philip Cunliffe Owen, he had brought some rubbings of bindings from the South Kensington Museum, which, he was happy to say, would be accessible to the public about July. These rubbings would dispel a general opinion that artistic leather binding was not known before the end of the 15th century. His researches had led him to the conclusion that artistic leather binding flourished in the 12th century. The general design was made up of a number of small tools—as many as 72 being used on one book. In early foreign work the design was executed with a pointed instrument, upon softened leather. He showed some specimens from Austria of the 12th century, which were bold in design, though he did not think they could be compared, as regards artistic merit, with English work of the same period. The specimens from Winchester and London of the 12th century were evidently the work of laymen, while others were from the monastery at Durham. Some of the early English bindings were in morocco, and some in calf, both having well stood the wear of ages. There was no doubt that calf could be prepared so as to last for an exceedingly long time, and good workmen used good materials; and at Bruges there were registers bound in the 15th century, in calf, which had been in constant use ever since, and were in a perfectly good condition until quite recently. These registers had been more injured during the last few years, by over-eager antiquaries searching for early printers' waste, than they had ever been before. He knew of several instances where bookbinders in the 16th century had introduced their own portrait on book-covers. In the 15th century, binding was more or less a commercial matter, and it might very well be imitated by binders in the present day. Two of the specimens were from Wurtemberg, and were exceedingly fine illustrations of binding. They were beginning to see the genesis of the design in stuffs, not attributing it to the Saracens of Sicily, but running much further back; and so with the designs for bookbinding. He had no doubt it could be traced up to the East. They must get hold of the genealogy, and in time he had no no doubt they would be able to do so. He had only found two fine early bindings in France which he had been unable to prove to be English; and only four in Germany, and three in Austria, which went back to the 13th century, and could be called artistic. He had found 27 English specimens of the 12th and 13th centuries, which were really artistic. Last year, he discovered a specimen from Dijon, which was extremely interesting; it was a folio, bound in the year 1367, and inlaid with coloured leather. The inlays were so well done, that they were in as perfect a condition as when first executed. The white leather was inserted in the brown leather, and in the case of the flowers there was a little metal ring, which helped to hold them down. Pig-skin was used in Germany for blind-tooled binding, but not in England.

Mr. ZAEHNSDORF said that during the last fifty years the advancement in the art of bookbinding had been very great. They were continually told that books could not be bound properly unless they were sent to France, but with this he could not at all agree, and the specimens now on view, he thought, would convince any one upon this matter. There had lately been put upon the market a journal called the "Bookbinder," and this was certainly a step in the right direction. In Germany there were four or five papers devoted to bookbinding, and if the Germans could support such papers, he thought in England they could the same. In Germany a guild had been formed for bookbinding, and an Act of Parliament had been passed that no master should take an apprentice unless he belonged to the guild. This was a step in the right direction, as it enabled the apprentices to be properly taught the art. Several schools had also been formed in Germany with the view of teaching the art of finishing. He was sorry that nothing had been said by Mr. Wheatley with regard to forwarding, which was a most important branch of the art, and required

careful consideration. As reference had been made to calf not being suitable for inlays, he must mention that in Vienna calf was largely used for this purpose. There were plenty of people who could produce good binding in England if a proper price were paid for it.

Mr. J. EASTTY thought this was very much a readers' question. It had been his custom, when he had read a standard book, to have it put into a first-class binding. Readers who could afford to have their books well bound might do much towards stimulating the art of the binder by coming into communication with him. If publishers would issue the sheets to persons who desired to have their own binding, much would be done towards the advancement of the art of bookbinding. The very best binding, apart from ornament, was the best economy, because if a leaf was lost, the book was spoiled. It used to be an old-fashioned plan for people to leave books by will, and if the books were well bound, the gift was much enhanced.

Mr. JOHN LEIGHTON said they ought to feel greatly obliged to Mr. Wheatley for taking up the subject of design in bookbinding. As a member of the Society of Arts who had discoursed upon the Library, and who some forty years since received recognition in this room from H.R.H. the Prince Consort for some hand-tooled and illuminated books designed by him, he was pleased to see the subject so ably advanced. The "extra" bookbinder, as he is termed, in contradistinction to the "boarder," or machine worker, has always had difficulties to contend with, in the first place, as to design, being the slave of conventional patterning patrons, who would hardly pay for the labour of the working of composite bits, let alone original gouging, filleting, or other ornamentation of noble character. In England, it cannot be said that we have made much advance in design over the art worker of the Middle Ages, save perhaps in precision of work and neatness of finish. Abroad, where the largest quantity of the best work has always been done, Monsieur le Reliure has somewhat of a status, he gets high prices for his labour, though greatly dependent upon Germans for his workmanship. Now, with regard to the publishers' bookbinder, the position is quite changed now. The art workmen were superseded by machinery that finishes a book-cover at a blow, the whole issue being alike, and dependent for sale upon its attractiveness. Thus an artist can be paid for an original design. In cloth binding and blocking we stood pre-eminent for at least a quarter of a century, having originated and, in fact, created the specialty. Foreign competitors have been our imitators heretofore, but they are now distancing us in the race. Hence the necessity for further effort here. He could remember when the works of French artists, both plate and wood, came to England to be engraved, and when half an edition of a *livre de luxe* went away to the United States, but it was not so now. The continental workmen, who are more delicate in their touch, having a better art training, rival us. In England, whole editions of books appear in cloth, whilst in France and Germany hardly the half appear boarded in *toile Anglaise*. For the convenience of the buyer all the finest books were obtainable in paper, which is an incentive to extra leather binding, and the tender handling of books. With regard to the publishers' cloth work, and the marvellous strides it took, growing from a mere lettering patch to an ornate coverture, more or less appropriate, all was due to art. In the dark ages of "extra" binding, workmen did, now and then, good things by tradition, and perpetuated admirable design in an ancient way, but when a new material came upon them it found them quite at a loss as original artists. Pugin had begun to demonstrate our ignorance of construction, and Owen Jones our defective colouring, but it was left to the great exhibitions of 1851 and 1862 to open our eyes, and to teach us Oriental art. At the advent of the Victorian era we had no artists with special training for cloth ornamentation, hence book decoration advanced but slowly, artists having been accustomed to work with pen and pencil upon white paper, instead of in chalk or gold upon black. Flaxman knew that white was relief, and that blue was space, as on the Portland vase, and in Wedgewood ware, but other artists did not. He well remembered that, in about 1839, one of the Royal Academicians furnished an elaborate picture to be cut in brass for the side of a book, in which all the whites came out black, and the lights darks—a thing that may be seen even to this day, for traditions stuck to us still. With regard to the bookbinding art of the future, the collector and the disseminator of literature should play an influential part, the patron and the publisher exercising a wide influence, but if they wished for excellence they must not, either of them, work by deputy. The publisher pays a good sum, and should see that he gets good design, and, moreover, that it is conscientiously worked out, and made to pass the ordeal of his own and of his artist's opinion, that is to say, if these tear-away times will permit of it. The patron of literature, not being a purveyor, has time and means at command, and should be able to beget the best work, and thus prove himself a benefactor to the future.

Mr. C. BUCKLAND said it had fallen to his lot to be associated with the principal bookbinders of the day, and in his early career he had the privilege of knowing Bedford, Riviere, Zaehnsdorf, and others. The firm with which he is connected did a considerable amount of general binding, but the difficulty which they experienced was to get people to pay a proper price; they would select this or that pattern, that back and lettering, but when they found what it would cost they at once began to murmur. Bookbinding, as an art, could not progress unless liberality was shown, in which case the binder would be able

to let his men have greater liberty in the display of skill. The master had to get a profit, and superior workmanship had to be paid for at a proper price, but the present tendency was to economise, and thus all extension in the art was prevented. If a proper price was paid it was not necessary to send books to Paris to be bound, as they could be equally well bound in England. The publication of the journal, "The Bookbinder," is a step in the right direction towards the diffusion of the art in its various branches, and he quite agreed with the previous speaker that the trade ought to be able to support a paper of its own. He hoped the very instructive lecture would be the means of helping forward the art of bookbinding.

Mr. WALTER CRANE said he had been extremely interested in Mr. Wheatley's admirable paper, and the beautiful examples he had shown. Not being a binder, he could only approach the subject from the designer's point of view, and in design his own preference was for working on what might be called constructional lines. The bordered and panelled blind-tooled covers (rubbings of which were exhibited by Mr. Weale) of the 12th and 13th centuries were very satisfactory as designs for book covers, and extremely beautiful in their details. His own efforts in designs for book covers had been rather with a view to production in a cheap form, and it should be remarked that a good design was not dependent upon expensive materials for its effect. It appeared, however, that one of the difficulties of modern book-binders was to command price enough to enable them to work out good designs in expensive materials. Perhaps one reason why the French appeared to spend more upon bindings might be found in the fact that all their books were first issued in paper covers (at a much lower figure than our cloth - bound volumes) and that, therefore, purchasers had more to spare when they wished to put their favourites into good coats. Mr. Buckland had touched on the true cause of the decline of art in bookbinding (as indeed of all art), which must be sought in the economic conditions under which we all lived—the commercial system of production under which two or three persons had to make their profit over and above the price paid to the craftsman or the artist. It was not likely that under such a system artistic work could flourish, and we had to put up with imitations and mere mechanical finish. It seemed to him there was a great charm in the old bindings in what would now be called roughness and imperfection—that variation in the tooling and slight irregularity which added so much to the richness of a design—so perhaps he was out of court in judging of modern bindings. The only immediate and individual solution of how to get artistic binding had been, he thought, found in the practice of his friend, Mr. Cobden-Sanderson, who had made himself practically acquainted with every technical part of the craft, executed all his own work himself, and spent his skill upon those books which he himself loved best—in short, working at bookbinding in the spirit of an artist.

Mr. L. DAY said he had been told, on what he thought good authority, that enamelling preceded inlaying, and he should like to ask whether any information could be given on this point. Personally, he could not say that he admired the effect of inlaying. Its invariable evenness of tint was most objectionable. Could not they employ varied skins, so as to get the kind of beauty which was obtained in marble and wood inlay? As to the allusion which had been made to cheapness, and to the public objecting to pay a large price for binding, he might say that binders had not paid sufficient attention to the designs; they habitually copied old examples which were not worth copying, and they spent a great deal of labour over work which was not worth the labour. For instance, if they repeated a little diaper pattern over a cover, it should only be on the grounds that it was perfect, but many of the things done were not at all perfect. With regard to cheapness, he thought the difference between modern and ancient bookbinding was due to a the difference of conditions. It was impossible for people to spend large sums on the binding of a single book, considering the enormous number of their books. When they had only two or three books they could afford to treat them like little gods, and worship them, but we had changed all that. He thought any real advance in binding must be in the simpler direction to which Mr. Crane had alluded. He did not see why designs should not be stamped and reproduced on cloth. The modern bookseller's notion of what was artistic seemed to be very hazy, and the publishers' idea seemed to be that niggling was finish. If modern binders would put less work into their blocks, and have them better cut, there would be more hope for bookbinding.

Mr. COBDEN-SANDERSON asked leave to exhibit some books which he had just received from Mr Lestrange Coffey, of Dublin. The books were covered with Persian, and were inexpensively bound, but it was to the decoration he wished to call attention. It was novel and interesting, and he hoped Mr. Coffey might receive encouragement to persevere in the craft which he had quite lately undertaken. Mr. Sanderson then went on to characterise the aims which he conceived the bookbinder should set himself, and the conditions under which he ought to be able to work. He said that at present the craftsman suffered from the too great pressure of tradition, both in forwarding and finishing. He had not time to to throw off the burthen and to come fresh to his work. A book should be treated as an individual. It should be well and carefully forwarded. Round or convex backs were not essential. He preferred a flat back, but

flat backs were not always attainable. If the book insisted upon assuming a concave form at the back he did not mind; the book itself was best judge of what form suited it best. Indeed, he, too, liked a concave back, and with his thumbs on the squares of the fore-edge, liked to feel his finger-tips resting in the hollow of the back. So with the fore-edge. Indeed, speaking generally, individuality of form was the essence of good bookbinding, and not box-like regularity. Decoration, it had been said, should be appropriate, and a book on zoology might be covered with animals; so a book of the time of Grolier ought to be decorated in the Grolier style. He not agree. Decoration was properly the expression of the craftsman's love of his work; it was the impress of the caress of his hand made upon the book he knew, had made, and loved, or it was nothing. So, in his opinion, the finisher ought to be also the forwarder, and should know something of the book he was binding. He should strive to do all he could for it, and having bound it well, should add just such touches of decoration as his own fancy playing over it suggested to him. If his fancy so playing was an original creative one, it would be well; if it could only remember and reproduce what others in like circumstance had done, it would not be so well; still it might be good. But if, in ignorance of the subject-matter of the book and its history, if it had one, the finisher attempts only to apply to a book which he had not himself forwarded a design he has not himself invented, or a design invented by him only as an "artist," the result, however brilliant the invention, must be lifeless, loveless, mechanical, not inspired by nor expiring affection. The appropriateness of decoration is infinitely more subtle than the somewhat gross appropriateness of same subject-matter and date, though these may very properly be borne in mind. Agreeing with Mr. Crane, Mr. Sanderson thought, too, that the craftsman laboured under a misapprehension as to the true finish of handwork, and confounded it with the finish of machine-made work The latter, pushed to its extreme, was smooth, even, lifeless: the former, at its best, was uneven, full of life, and bearing everywhere traces of its origin in the sensitive ever-varying hand and mind of man. These are some of the characteristics of good bookbinding, but to attain them the condition of the craftsman in bookbinding, as in every other craft, must be far other than it at present is. How is it possible for a man, kept at work from early in the morning to late at night, week after week, year after year, on low weekly wages, for a public which above all things prizes what is cheap, and never comes into contact with or appreciates the aims of the craftsman or the craftsman himself—how is it possible for such a workman to free himself from the pressure of tradition, to escape doing what under the circumstances is easiest to do—to fall into the rut, and to imitate, and to find perfection in the death of his emotions, and in the production of work such as a machine might do? It is impossible, and those who are interested in the craft of bookbinding and in its lovely adornment must take this condition to heart, and do all in their power to amend it. Schools of design, and books and literature devoted to "art" and its "encouragement," are and will be an absurdity so long as art, or the decoration of a thing, is divorced from the making of it, and so long as the conditions under which a modern craftsman works are as they are.

The CHAIRMAN having proposed a vote of thanks to Mr. Wheatley for his paper,

Mr. WHEATLEY, in reply, said that Mr. Weale had referred to the strength of calf in the oldest books, but calf, as prepared at the present day, was too weak to bear much wear, and therefore was unfitted for the elaborate ornamentation which was expended upon morocco. With regard to Mr. Cobden-Sanderson's remarks respecting the prevalence of imitation in bookbinding, he thought that the exhibition downstairs showed that now this objection had been greatly overcome, and that much quite original work was produced. In conclusion, he wished to thank those who had so kindly assisted him. First, there were the authorities of the British Museum, who had allowed him to take copies of some of their priceless treasures for the lantern slides, and he was especially indebted to Mr. Bullen and to Mr. Fletcher. Mr. Weale also had kindly brought to the meeting some of his rubbings of beautiful bindings; then there were those who had kindly lent so many fine specimens of binding for exhibition. Mr. Zaehnsdorf and Messrs. Riviere also, besides lending books, had lent some of the lantern slides.

SIR GEORGE BIRDWOOD writes:—"I said nothing last night in the discussion on Mr. Wheatley's valuable and interesting paper, not simply on account of the lateness of the hour when I might have spoken, but because I desired to prolong the pleasure of an exceptionally enjoyable evening by dismissing the meeting while we were all still under the spell of Mr. Cobden Sanderson's animated address. But while he altogether commanded my sympathies for the time, I cannot, in this morning's wintry air, pretend to accept the unreserved and uncompromising terms in which he denied the value of tradition—that is, of the teachings of the history of its own development—in art, and particularly in the applied arts. In the latter, the decorative arts (and I never pretend to speak of the illustrative or fine arts), I regard the authority of tradition—the transmitted "Testament" of countless generations of craftsmen—as of the utmost practical importance and utility. The last word in this controversy was said long ago, by Sir Joshua Reynolds. An industrial artist of inborn genius may find himself enabled, by the unaided inspiration of nature, to produce work that pleases

everybody; but even such an one, if he would press forward to the farthest goal within the reach of his superior mental powers, must have a knowledge of the principles and processes, particularly with reference to the interpretation of nature for the purposes of ornamentation, established by others who have devoted themselves to his own handicraft—that is, he must be guided by the experience of those who have preceded him in the path he is pursuing, and by whose labours it has been made straight before him, if he will but thoughtfully follow it in their footsteps. On the other hand, for the mass of handicraftsmen tradition is the only safe path, and we must be content with their blindly adhering to the decorative interpretation of nature received by them from former generations. And, really and truly, there is no getting away from tradition. The Caucasian races by whom the world has been civilised have been not 5,000 years merely but nearer 50,000, in elaborating the several varieties of their essentially identical arts. Mr. Wheatley objected to using the French *fleur-de-lis* as a diaper in English bookbinding. But apart from the fact that English bookbinding, as we have known it from the time of the Reformation, is French, the *fleur-de-lis* itself belongs not only to the French but to all the Aryan races, and is frequently to be met with in the art of India of all periods. Again, in bookbinding, the old method, still used in all countries, of laying the gold on a paste of red lead and vermilion, originated in the practice of our idolatrous ancestors of painting the images of their phallic Sun-gods red, as is still done in India, before they took to gilding them. We cannot, in fact, get away from tradition if we would. That is, we cannot, do what we will, get away from ourselves; that stupendous whole in time and space, of which we are all, each in his appointed day and sphere, transmitted effect and transmitting cause. This tyranny of tradition, transmitted through the physical world to the intellectual, is not in the least antagonistic to that appreciation of the beauties of nature which is the vital air of every living art. The arts of India are the most conventional of any known to us; and yet the Hindus are, in every part of India, characterised by the deepest love of nature. This is seen in their literature, and it is seen also in the copiousness of the technical vocabularies of the colour used by their hereditary handicraftsmen. But, above all, it is seen in the inexhaustible permutations under which they have, in every age, been accustomed to paraphrase the few decorative elements originally derived by them from the mythology and cosmogony of the Chaldeans—the source of nearly all the traditional motives of the ornamental arts of both the West and the East. Unity—absolute unity—in multiplicity, is the universal law of nature, and no more in the arts than in any other department of human activity can we overpass the limits of the unity imposed on them by our own constitutions, although we may infinitely disport ourselves within the bounds of its boundless circuit. It was very interesting to trace the influence of the East on Western bookbinding in so many of the examples exhibited in illustration of Mr. Wheatley's paper. Mr. Weale's rubbings from the old English leather bindings of MSS. of the 12th and 13th centuries, prove that they have no connection at all with our modern English binding, but they, still more directly than the latter, bear the stamp of their Eastern pedigree though Byzantium. But before this type of bookbinding had time to fully naturalise itself in England, there came the great breach in the traditional development of all our native arts caused by the violent revolutionary spirit in which our rude gross race carried out the Reformation. We had, therefore, to begin over again in everything, and we borrowed our revived art of bookbinding, for so we must distinguish it after the revelations made by Mr. Weale's researches, from France. But its type was still Eastern, having been derived by the Italians through Genoa and Venice from Persia, and Syria, and Egypt, and India, and by the French from Italy; Grolier, the treasurer to Francis I., having been governor of Milan. From France Queen Mary transplanted the art into Scotland, and from Scotland it was introduced by James I. into England; and John Gibson, who was binder to James I., was the real founder of modern English bookbinding, as perfected at the end of last century by Roger Payne. *Ex Oriente lux.* Everything in the West has come from the East; the human race, our domestic animals, our historical flora, our alphabets, coinages, old ethnic gods, and our arts, even to this last and least of them all, the art of bookbinding. I was not prepared for the disparaging tone in which our characteristic modern English leather bookbinding was spoken of by some who took part in the discussion. It seems to me as admirable, in the adaptation of means to an end, as could be. Our cloth binding at its best, as for example in the original binding of 'The Story of the Volsungs and Niblungs,' translated by Morris (Ellis, 1870), could surely not be bettered. It is absurd to bind books produced in editions of hundreds and thousands in the costly manner in which the Byzantine Greeks and the Romish monks bound, or rather enshrined, their unique and priceless MSS. As books also are now printed mechanically, and not written, it is an affectation to insist on their bindings not merely being hand-'tooled' but roughly wrought in laboured imitation of early pigskin bindings. To be consistent, we should go back to the use of manuscript, or at least to that of wooden types and hand-printing in the reproduction of them. Still, every lover of books would be glad were it possible, without going to a ruinous and, indeed, incommensurate expense, to have his own personal bookbinding. The difficulty is to find in 'the trade,' as at present existing, any one capable of giving proper artistic effect to one's suggestion; or, on the other hand, artists who

would undertake 'inferior decorative art' of the sort. But if professional artists would condescend to such humble commissions, it would be possible for people of but comparatively modest means to have their own designs for bindings, and to get the proper tools for them cut; and these would be transmitted from generation to generation as useful and most interesting heirlooms. If this could in any way be brought about, artistic bookbinding in England would receive a most salutary impulse, and give fruitful employment to a vast amount of skilled talent that only requires practice to bring it to perfection."

An exhibition of historical and modern bookbindings illustrative of the paper was opened on Tuesday evening, 14th inst., and was continued during the week. Between four and five hundred persons visited the exhibition during the four days it was open. The follow- is a catalogue of the exhibits :—

ORIENTAL BINDINGS.

Persian book covers, from the Shah's library at Teheran, 16th century. Thick, black lacquer, on a ground of gold leaf, ground up pearl or shell used as inlay. In frame.

Book covers from Ulwar, in frame. The books from which they were taken are the celebrated Koran and Gulistan of the Royal Library at Ulwar. These books were rebound in 1884, and then valued at 3 lakhs of rupees, or £25,000.

[Lent by Mr. C. Purdon Clarke, C.I.E.]

Persian book cover in frame. [Lent by Mr. Zaehnsdorf.]

OLD BINDINGS AND EXAMPLES OF BLIND TOOLING.

CASE I.

MS. of the 14th century on vellum, in stamped vellum.

English MS. of the 14th century on vellum, in rough leather, with clasps, and with long loose end, to be attached to the girdle.

Old Ethiopic MS. on vellum, in leather case, with leather thongs.

[Lent by Messrs. J. and W. J. Leighton.]

Examples of stamped pigskin and calf. [Lent by Sir George Birdwood, Mr. Zaehnsdorf, and Messrs. J. and W. J. Leighton.]

Folio volume in brown morocco, with blind tooling, by Riviere. [Lent by Messrs. Riviere.]

Small volume, in modern blind tooling (Loftie's "Latin Year"). [Lent by Sir George Birdwood.]

HISTORICAL BINDINGS (ENGLISH).

CASES II. AND III.

English bindings in gold tooling of the 17th. 18th, and 19th centuries by unknown binders, by Roger Payne, Kalthoeber, Charles Lewis, Mackenzie, Nutt, Bedford, and Hayday. [Lent by Mr. Bain, Mr. W. G. Thorpe, and Messrs. J. and W. J. Leighton.]

Specimen of binding adopted by Thomas Hollis, with figure of Britannia on the side.

Volume in green morocco, with cameo of the authoress (Mrs. Tighe) on the side. [Lent by Mr. Bain.]

Three folio volumes in elaborate gold tooling of 17th century. [Lent by Mr. Zaehnsdorf and Messrs. J. and W. J. Leighton.]

HISTORICAL BINDINGS (FRENCH, ITALIAN, AND MODERN INDIAN).

CASE IV.

Volume in red morocco, with arms of De Thou on the side.

Volume in calf, with elaborate Grolier design.

Fine specimens of elaborate tooling, some of the Italian with fan ornament in the corners, of the 16th and 17th centuries. [Lent by Mr. Henry S. Richardson and Messrs. J. and W. J. Leighton.]

Two blank volumes in leather binding, elaborately tooled. Modern Indian work. [Lent by Sir George Birdwood.]

CASE V.

Five folio volumes in elaborate gold tooling of the 16th and early 17th centuries. [Lent by Messrs. J. and W. J. Leighton.]

MODERN BINDINGS.

CASE VI.

Examples of modern bindings in morocco, with elaborate gold tooling in Grolier, De Rome, and English cottage styles, and in floral and other original designs. [Lent by Messrs. Riviere.]

CASE VII.

Specimens of modern binding in morocco by Zaehnsdorf, with gold tooling and inlays in Japanese and other original designs. [Lent by Mr. Zaehnsdorf.]

CASE VIII.

Four octavo volumes in red and brown morocco, in blind and gold tooling. [Bound and lent by Mr. Holloway.]

Three octavo volumes in red, blue, and green morocco, with elaborate gold tooling in original floral designs. Designed and bound by Mr. Cobden Sanderson. [Lent by Mr. Cobden Sanderson.]

Two octavo volumes in vellum, with gold tooling and painted designs. *Doublés* in orange calf, tooled in gold, with pencil design on vellum in centre (Milton). [Designed and lent by Mr. John Leighton.]

Two octavo volumes in vellum, with elaborate gold tooling and painted designs (Yule's "Life of Marco Polo"). [Lent by Sir George Birdwood.]

Small volume in red morocco, by Mame, of Tours. [Lent by Mr. John Leighton.]

Two volumes in morocco, with original designs, by Hawes, of Cambridge. [Lent by Mr. Granger Hutt.]

Two volumes in Spanish morocco, with gold border. [Lent by Messrs. J. and J. W Leighton.]

Case IX.

Original design for binding on paper, in colours. [Lent by Messrs. Riviere.]

Volume in brown calf, with printed design.

Several volumes in various coloured morocco, bound elaborately, tooled and plain, by Messrs. Leighton. [Lent by Messrs. J. and J. W. Leighton.]

Three volumes in fawn and green Persian, with raised original design, by recently introduced method by Mr. and Mrs. Coffey, of Dublin. [Lent by Mr. Cobden Sanderson.]

Volume in tree-marbled calf, with tree-marbled *doublé*. [Lent by Mr. J. Eastty.]

Cases X. and XI.

"Dante," folio, in fawn-coloured morocco, elaborately tooled in colour and gold, with portrait of Dante on the sides, by Riviere.

"Domesday Book," folio, in morocco, elaborately tooled with original design by Godfrey Sykes; bound by Riviere.

Two folio volumes in dark morocco, elaborately tooled with geometric designs by Riviere. [Lent by Messrs. Riviere.]

Folio volume in purple morocco, with tooled border, by Nutt.

EXAMPLES OF BINDING IN VARIOUS MATERIALS.

Case XII.

Cover stamped and coloured in Japanese design, for *Le Miroir du Monde*. Lent by [Mr. Zaehnsdorf.]

Quarto volume, in half morocco. [Lent by Messrs. J. and J. W. Leighton.]

Two volumes in white parchment, with stamped designs in gold colour and blind.

Cover in parchment, with gold Arabic design. [Lent by Messrs. Burn and Co.]

Book bound in tortoiseshell, with silver hinges, clasps, and corners. [Lent by Sir George Birdwood.]

Book with inlaid wood sides, floral design.

Two Oriental slippers, with design cut in the leather. [Lent by Sir George Birdwood.]

Blotting-book, covered with embroidery on velvet.

Book cover, with floral design embroidered in gold on cloth, by members of the Royal School of Art Needlework. [Lent by Mr. D.P. Fry.]

Examples of painting on parchment ("Book of Psalms," "Three Martyrs," and Prayer Book).

Raised ornament on vellum and parchment, in gold, silver, and colour (Dictionary and Shakespeare's Sonnets).

Two specimens of embroidery on parchment. [Lent by Royal School of Art Needlework.]

HISTORICAL COLLECTION OF PUBLISHERS' BINDINGS.

Case XIII.

Example of paper boards, with title printed on paper label on back. (Southey's "Omniana," 1812.)

Example of Roxburgh style. Introduced in 1812.

Example of paper boards, with cloth back and paper label. Introduced in 1822.

Example of whole cloth with paper label.

Example of whole cloth, with paper label, stamped with gold.

Example of whole cloth, title stamped in gold direct on back. Introduced in 1832.

Example of whole cloth, blocked design in blind. ("Sketches by Boz.") [Lent by Mr. J. Leighton.]

Examples of whole cloth, block design in blind and gold.

Various covers of modern designs in blind, gold, and coloured printing. [Lent by Messrs. J. Burn & Co. and Mr. John Leighton.]

Case XIV.

Examples of modern work in paper covers, with coloured designs by Mr. Walter Crane, Miss Greenaway, and others.

Two volumes, cloth, with original designs in gold by Mr. Lewis F. Day. [Lent by Mr. Day.]

Cloth covers, with original designs in gold by Mr. William Morris ("Story of the Volsungs and Niblungs"), Mrs. Orrinsmith (Works of Tennyson), and Dante Rossetti ("Ballads and Sonnets").

ILLUSTRATED WORKS ON BOOKBINDING.

CASE XV.

"Manuel Historique et Bibliographique de l'Amateur de Reliures. Par Leon Gruel." Paris, 1887. 4to. [Lent by Mons. Gruel.]

"La Reliure Ancienne et Moderne. Introduction par Gustave Brunet." Paris: E. Rouveyre and G. Blond, 1884. 4to.

"La Reliure de Luxe; Le Livre et l'Amateur. Par L. Derôme." Paris: E. Rouveyre, 1887.

"La Reliure Moderne Artistique et Fantaisiste. Par Octave Uzanne." Paris: E. Rouveyre, 1887.

"Les Reliures d'Art à la Bibliothéque Nationale. Par Henri Bouchot." Paris: E. Rouveyre, 1888.

[Exhibited by Mons. Rouveyre.]

Rubbings of Book Covers. Exhibited by Mr. Richardson.

Three frames containing cloth book covers and designs for cloth binding. Lent by Mr. John Leighton.

New issue of "Encyclopædia Britannica," bound in cloth, with new design by Mr John Leighton. Lent by Messrs. A. and C. Black.

Specimens of French and German cloth bindings, with gold and pictorial designs. Lent by Messrs. Williams and Norgate.

TENTH ORDINARY MEETING.

Wednesday, February 22nd, 1888; Sir HENRY ROSCOE, M.P., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Chapman, A. G., Pierrepoint-lodge, Springfield-park, Acton, W.

Sykes, Benjamin Clifford, M.D., M.R.C.S., St. John's-house, Checkheaton, Yorks.

Debenham, Frank, 26, Upper Hamilton-terrace, N.W.

Forsyth, Rev. James Shepherd, M.A., 33, Stock Orchard-crescent, Holloway. N.

Jones, H. Macnaughton, M.D., F.R.C.S., 141, Harley-street, W.

May, Gustav Adolphus. 2, White Hart-street, Paternoster-square, E.C.

Parker, George, 3, Ambleside-avenue, Streatham, S.W.

Whiteacre, William, 4, Marine-terrace, Whitehaven.

Winstone, Ernest H., 2, Victoria-mansions, Victoria-street, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Collins, John, Analytical Laboratory, Bradford-buildings, Mawdsley-street, Bolton-le-Moors, Lancashire.

King, Frank, 38, Chesilton-road, Fulham, S.W.

Ransome, Allen, Stanley Works, King's-road, Chelsea, S.W., and 26, The Boltons, South Kensington, S.W.

Smith, Grimston Abel, Romford, Essex.

Vincent, Frederick Gillmore, 9, Southwark-bridge-road, S.E.

The paper was read—

THE TECHNICAL EDUCATION BILL.

By SWIRE SMITH.

It is a remarkable fact that, although for ages past it was considered necessary that our professional classes should go through prescribed courses of scholastic training in order to prepare them for their subsequent occupations, there was no such appropriate training considered necessary or offered to the commercial and industrial classes of the United Kingdom. For our lawyers, doctors, divines, literary men and others, the public schools and universities of the country, with their magnificent endowments—intended in many instances for the education of the poor—have supplied great opportunities and advantages of special training, but there have been no schools until recently, either public or private, which offered, even in a remote degree, scholastic training suited to the requirements of the engineer, merchant, manufacturer, farmer, or skilled artisan, the men upon whom the development of the resources and the material prosperity of the country really depended.

And in most instances when the necessity for such training was urged, its advocates were denounced as men who would degrade education into mere utilitarianism. It has only been since a number of rude blows have

been struck at our commercial supremacy by some of our highly-trained manufacturing rivals in other countries, and since our great agricultural industry has been almost paralysed by the competition of the outsider, that public attention has been drawn to the question of education in its relation to the industrial and commercial requirements of our people. In fact, it may be said that it is almost entirely in its relation to foreign competition, both as to manufactures and agriculture, that the question of technical instruction has been brought to the front in this country.

Appointment of Royal Commission.

It was for the purpose of obtaining information on all the bearings of this question at first-hand, that Mr. Mundella recommended to his Government the appointment of the Royal Commission on Technical Instruction in 1881. And in order that practical experience in industrial undertakings should be brought to bear upon the inquiry, the great industries of iron, cotton, wool, pottery, and chemicals, as well as scholastic knowledge, were represented upon the Commission.

The only claim that I can have to the honour of being invited by the Society of Arts to read a paper to you on the Technical Education Bill is based upon the fact that it was my privilege to serve on that Commission, and that, in addition to the experience which I gained in association with my colleagues in visiting the leading technical schools of Europe and America, and in estimating their influence upon the several industries which they were intended to promote, I have also for some years taken a practical interest in founding and conducting some of the leading technical schools in Yorkshire.

I feel it to be necessary to refer to the labours of the Technical Commission, because I wish you to consider, from my standpoint as an actual observer, the character of the industrial struggle in which we are engaged, and the vast importance of prompt and effective action in meeting and overcoming our difficulties. But it must be understood that, beyond the conclusions and recommendations to be found in the report of the Commission, my colleagues are not responsible for any opinions that I may express.

Methods of Inquiry.

First, as to our methods of inquiry. We considered it necessary to inform ourselves as to the nature and extent of the foreign competition from which the several industries in this country were suffering, and in order to satisfy ourselves upon all points of detail, we visited the leading industrial districts in the United Kingdom; we inspected factories and workshops, and received evidence from representative men in each industry as to the causes which, in their opinion, promoted or retarded the prosperity of the many branches of British commerce. We also visited many of the schools and classes in this country in which the theoretical training of employers, foremen, and workmen had been received.

Having ascertained the origin of the various foreign manufactured products which were displacing those of the United Kingdom in our own and neutral markets, we visited the manufacturing countries of Europe, and, through the courtesy of foreign employers, inspected many of the great industrial establishments of our competitors. With all the details of the processes of manufacture before us, we traced as far as possible each advantage of our rivals in superiority or cheapness to its source. We visited the schools in which employers, foremen, chemists, designers, and art workmen had received their theoretical instruction, and, as bearing indirectly upon our inquiry, we took every opportunity of obtaining information as to the rates of wages and hours of labour, the influence of piece-work, division of labour, protective duties, the military systems, and other conditions which, in each continental state, more or less affect the cost of production and the quality of the manufactures.

England the Industrial Pioneer.

Our inquiry showed very clearly that the modern manufacturing systems of every country are modelled on those of England. In many instances we found that factories had been designed and furnished throughout by English machine makers, while many foreign manufacturers had been taught their trades by Englishmen. All the best machinery that we saw was English, or had been copied from English, and this applied to most of the machine tools in foreign workshops.

In matters of organisation, labour-saving appliances, &c., our imitators have followed us so closely that the best continental factories approach very nearly to our own. The proportion of modern new works to the whole in each industry is greater in Germany and some other countries (particularly in the United States and Canada) than in England, where

there are many large establishments in which large fortunes have been made, but which are not equipped in the best and most economical style for the competition of to-day. In the outward conditions apparent to the eye the advantages of economy of production often appeared to be in favour of the foreigners, but in nearly all the cases in which we were enabled to sift the evidence, the real advantages were on the side of this country. There were important exceptions to this rule, and in noting the rapid strides that have been made, and taking account of the long hours and the low wages of continental operatives as compared with our own, it did seem that in the production of staple goods and metal work of various kinds we are within measurable distance of being equalled, if not surpassed, "all along the line" by our most advanced rivals, assuming that other existing conditions remain unchanged.

"Goods for the Million."

This country, as everybody knows, has made its wealth and formed its "connexion" by the manufacture and export of "goods for the million." We have never been famed in the past for the artistic qualities or taste of our machine-made productions, and in truth, in the prosperous times some years ago, there was but little temptation to trouble about the making of new patterns so long as the machinery could be kept going at a profit on the old ones. But a change of immense importance has come, as I will briefly explain. The English foremen who accompanied English machines to other countries first taught the foreign manufacturers and operatives to make such goods as were being made in English factories, viz., the goods for the million. Favoured by cheap labour, long hours, and heavy protective duties, each country began to supply its own markets with the products which had hitherto been imported from England. It has been said that for every English machine that was started in France, Germany, Belgium, Austria, Russia, and in the United States and Canada, a similar machine employed in England on goods for those countries was displaced. By such means we lost some important branches of our export trade in common staple goods, of the value of many millions of pounds sterling annually, and this fact in itself accounts for much of the commercial depression from which this country during recent years has so seriously suffered. In the struggle for existence which we find in every country, and with the measures of protection with which our rivals endeavour to lighten the burdens of their operatives, we cannot contend. Of one thing, however, I am convinced, that never again, under normal conditions, so long as foreign manufacturers are protected by high tariffs, shall we export to such countries as I have named any large proportion of those staple goods and commodities the profits upon which in the past have been mainly instrumental in building up the enormous industrial wealth of the United Kingdom.

Thus far I have spoken of the loss of our export trade in manufactures to protected countries. I need not dwell upon our export trade in goods for the million to non-manufacturing countries, in which as yet, in spite of all competition, we "hold the field," although, as in our own markets, we have to contend against the surplus products of our rivals.

Increase of Imported Manufactures.

It is, however, in our import trade that our weak points as manufacturers are most seriously exposed. While our exports have suffered curtailment, the more advanced of the Continental countries have not only supplied their own markets with common goods, but have opened up a most important export trade in attractive goods and novelties which not only supersede British goods in neutral markets but find their way in ever increasing quantities to our own. To put the case briefly, I may say that the Technical Commissioners, in conducting this branch of our inquiry, ascertained that our imports of foreign manufactures, with some exceptions, were not due to the longer hours and the lower wages of foreign operatives, as is generally supposed, but to the superiority, attractiveness, or novelty of the goods themselves.

Superior Training of Foreign Manufacturers.

We discovered, often to our great surprise, English machines in foreign countries producing more effective, more attractive, and more saleable goods than were being produced by English machines in competing establishments in this country. In the second place, we found that the special qualities which promoted the sale of foreign products, so largely imported by the people of this country, were due to the scientific or artistic training of employers, foremen, designers, chemists, or workmen, in the establishments where the goods were pro-

duced. In every industry, in competing countries abroad, those persons who are responsible for the designing, shaping, finishing, colouring, or making up of a fancy article, whether it be in metal work, pottery, furniture, or a woven or printed fabric, have almost invariably received some training in art or science, or have gone through a special technical school. In England, the majority of persons holding similar positions, have received no artistic or scientific training whatever, except, when as often happens, those positions are held by foreign designers or chemists, or by Englishmen who have been trained in foreign countries.

And if we discovered that one of the chief causes of our deficiency in the production of saleable commodities was to be found in our lack of scientific or artistic training, we discovered also that the superior "methods of commerce," on the part of some of our neighbours, was equally due to their more appropriate scholastic instruction. The foreign correspondents in the merchants' offices in our large towns, who are employed because Englishmen of equal linguistic ability and training could not be obtained; the foreign agents and travellers from Germany and other countries, scattered all over the world, pushing the business of their respective firms and countries, have qualified for their positions by a commercial training which has hitherto been almost inaccessible to the Englishman.

It is sufficiently humiliating to be compelled to acknowledge that, in the industrial contest of to-day, English machinery is being employed to better and more profitable account by some of our rivals than by ourselves; but it is infinitely more serious and more humiliating to find that in the conditions of training which best tend to promote future efficiency and success, the rising generations of other countries are being far better prepared than those of England.

Dangers Ahead.

Our practical difficulties are twofold. As I have explained, we have lost our trade with rival manufacturing countries in common goods through their protective tariff, a loss to us of many millions sterling annually. In the next place, we are falling behind in our home trade in attractive goods, because of the lack of skill, taste, and knowledge, on the part of our employers, foremen, and some of our workmen, as compared with their rivals. Just in proportion as nations manufacture for themselves they will import less of common goods which we have hitherto made, and as they advance in wealth they will buy more and more of attractive goods or novelties, in which we are behind our competitors. In either case our position is perilous in the extreme. We can only pay for the imported food of our people, amounting to £130,000,000 annually, by exporting the produce of our labour and skill. But in doing this we must compete with the cheap labour of our rivals in all parts of the earth; we must overcome their protective tariffs at their own ports, and we must meet their equipment of skill and taste with an equipment equally effective. Under conditions of life so artificial as ours, the war of swords, terrible as it is, is a small matter when compared with the unceasing war of commerce. To be temporarily under-sold by our competitors in any market means loss of capital and employment, but to be permanently under-sold means reduced wages, a lowering of the standard of comfort of our people, and the decline of our country. These eventualities we have to face, and to overcome, at all cost.

We see in our markets what cannot be seen elsewhere—the best and the cheapest commodities of the foreigner placed on equal terms side by side with our own. There is no population possessed of the purchasing power, on the one hand, and on the other so favoured, as ours, in their opportunities of procuring tasteful materials for domestic use. While our people have wonderful facilities for purchasing beautiful things, they have, in a great measure, been deprived of the training by which alone the beautiful things can be made. Hence they are under the constant temptation of buying foreign articles, instead of spending their money in the encouragement of our home industries.

To me there is but little consolation in knowing that we take the lead in our trade in common goods with semi-civilised and non-manufacturing nations, if our neighbours across the channel surpass us in the trade in those superior and tasteful goods which are so largely purchased by the wealthy and the most refined of our own people.

The warehouses and shop-windows of every town reveal to us the weakness of our industrial position, and I have found, by unpleasant experience, the same exhibition of our weakness in all countries that I have visited. The problem which has to be solved, and which is the most important industrial problem of the age, is easily stated. First surpass the

foreigner in our own markets, we shall then surpass him in all the neutral markets of the world.

Present Experience.

I have taken up so much time in bringing before you some of the weak points of our industrial position, as compared with that of our leading competitors, that I cannot describe in any detail the educational systems of foreign countries that have contributed so much to the results achieved. Nor can I recount the efforts that have been made in this country to supplement our shortcomings and meet our deficiencies. But as most of you are already acquainted with the systems of education at home and abroad, I have thought it prudent to dwell more upon our industrial deficiencies, with which many of you will be less familiar. I may state, however, that even with such educational facilities as we possess, in those instances in which they have been fully utilised the results achieved have been of a character to justify the highest expectations of success from the adoption of extended systematic instruction and training. English manufacturers have by no means lost their enterprise, nor our workmen their strength and energy, and when in suitable buildings the facilities even now offered by the Science and Art Department have been fully taken advantage of, and localities have availed themselves of the assistance so generously offered by the City and Guilds of the London Institute and the Livery Companies of London, the theoretical and practical instruction not only of workmen and foremen but of employers also has exerted a powerful influence in enabling them to deal with some of the most serious difficulties connected with our industrial position.

Effect of Comprehensive Measure.

I believe that by carrying into operation a Technical Instruction Bill, wise and just in its provisions, applying to agriculture as well as to commerce, meeting the wants of the artisan, the foreman, the commercial man, the employer, and taking effect in every parish in the country, new vigour and force will be given to our British industries, and the well-being and prosperity of the nation will be materially increased.

In considering this question, we must keep clearly before us the fact that our aim is to develop, through a more highly cultured people, our industrial system; to regain of our commerce what we have lost; to retain and improve that which we hold. In so much as education can help in this movement, then education must be supplied, and with no niggardly hand. We have to cope with countries which have organised their education as thoroughly as they have organised their military systems, and with the same regardlessness of cost; indeed, they have found that the union of scientific knowledge with practice, which forms the best equipment of nations in the arts of war, also forms their most formidable equipment in the arts of peace.

Technical Education Abroad.

Education appropriate to the needs of life is supplied in those countries whose competition is to be feared, to all sorts and conditions of men and women. The course begins at the bottom, and ascends by consistent steps to the top, so that all men and women may have opportunities afforded them of receiving that particular instruction which will best help them in their daily wants.

Begin at the Bottom.

If in any country practical education is necessary, it is surely in this the greatest country of skilled traders in the world. Therefore our industrial system must be strengthened at the very beginning of the training of our people, and upon that foundation we must build a system of technical instruction, leading consistently from elementary to secondary, and from secondary to the highest facilities for the obtaining of scientific, artistic, and industrial training.

In suggesting this programme I go far beyond the Technical Instruction Bill of the Government, which was submitted to the House of Commons and withdrawn after passing its second reading last Session.

Technical Education Bill of 1887.

Briefly, the object of the Bill was to enable a local authority—a School Board, or Council of a Borough where there is no School Board—to supplement by technical instruction the elementary education supplied in its district. Power was given to each district to provide technical schools out of the local rates; to combine for the purpose with any other local authority, or to contribute to the maintenance, or provision and maintenance of any technical school with the sanction of the Science and Art Department. The conditions required were that each scholar receiving local aid should have passed the Sixth Standard of the

Education Code, and that each school provided under the Act should be conducted in accordance with the minutes of the Science and Art Department, which were to be fulfilled by such a school in order to obtain a grant from that department.

To provide for objections on the part of ratepayers, power was given, under Clause 3 of the Bill, for opposition to its adoption by a written requisition of fifty ratepayers demanding a poll of votes of the locality. This clause, however, did not apply to the metropolis, nor was it included in the Bill for Scotland.

The term "Technical Education" was defined as instruction in the branches of science and art with respect to which grants are or may be made by the Science and Art Department, and I propose to adopt the same term in my own suggestions which follow.

I will not comment upon the Bill, further than to express a hope that the provision for a poll of the ratepayers—which seemed to have been inserted in order to tempt localities to refuse to carry it into effect—will not appear in the new Bill.

The provisions of the late Bill have been much discussed during the recess, and I think it will be admitted that public opinion is in favour of a measure that will more adequately meet the necessities of the situation. For your consideration, and as friends of the movement, I beg to submit the following suggestions, which appear to me to be appropriate for embodiment in any Bill that is submitted to Parliament.

Suggestions for Technical Instruction Bill.

In order to bring our system of education into harmony with the immediate wants of each locality, and to enable our people, consistently with our national habits, to obtain such technical training as will materially help them in the practical work of life, the following educational provisions are necessary:—

First, as to Elementary Education—under School Boards and voluntary school managers.

1. *Infant Schools.*—The introduction of the Kindergarten methods of instruction should be everywhere encouraged, as tending to the development of skill and observation on the part of the children.

2. *Elementary Schools.*—

(*a.*) That drawing be taught universally to boys and girls, and that the teaching of modelling be encouraged by grant.

(*b.*) That the teaching of elementary science be encouraged in the upper standards.

(*c.*) That for the better teaching of drawing, modelling, and science, every school be furnished with appropriate models, casts, and examples, suitable to the requirements of the scholars of each locality.

(*d.*) That grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums.

(*e.*) That in connection with each elementary school, or group of schools, a room be fitted up as a workshop, with provision for the instruction of every boy in the use of simple manual tools during his last year of schooling, and that a grant be made upon workshop fittings and tools, and upon the instruction, in accordance with regulations to be made by the Educational Department. This instruction to be given out of school hours if possible, and factory half-timers to be exempted from it if considered desirable.

(*f.*) That in agricultural districts the use of tools and the facts of agriculture be taught to boys, and that, where possible, garden plots be secured for practical instruction.

(*g.*) That in addition to drawing and needlework, the elements of cookery and household management be taught to all girls in the upper standards.

(*h.*) That Government grants on drawing, elementary science, the use of tools, and cookery, be sufficiently large as to encourage teachers and managers to give due attention to these subjects.

(*i.*) That children should not be allowed to work as full-timers under 14 unless (as in Scotland) they have passed the 5th Standard. That this regulation be subject to the following exemption, viz.:—That attendance in an evening continuation school for one year—subject to the restrictions as to regularity of attendance and presentation at the examination under H.M. inspector—be allowed as an equivalent to half-time attendance at a day school between 13 and 14.

Beyond the above simple provisions, which would not seriously affect the existing arrangements, or entail much extra cost upon the country, it does not appear necessary at present to introduce technical instruction into elementary schools.

The modifications suggested would tend to lighten rather than to burden the tasks of the scholars, by making school work much more interesting than it is at present. Such instruction would supply the rudiments of a

technical education for artisans, and would materially help all boys and girls, irrespective of their intended career, to be "handy." It would bring the day school into harmony with the workshop, and would prepare the scholars for the scientific and technical instruction of the night school, or for advancing into the secondary day school.

3. *Continuation Schools* — under School Boards and voluntary school managers:—

(*a.*) The standard subjects should be taught as at present, with the addition of drawing, modelling, elementary science, and manual instruction for boys, and needlework, cookery, and household management for girls.

(*b.*) Increased grants should be given for attendance and general efficiency, independent of the passes in standard subjects.

(*c.*) The admission should be free.

(*d.*) The deficiency of income over expenditure to be defrayed out of the School Board fund in the case of Board schools.

Under the Technical Instruction Bill the functions of the School Board should terminate with the organisation of elementary education, with the exception of such powers as School Boards already possess for conducting instruction in higher grade Board schools.

4. *Secondary Technical and Commercial Schools.*—

(*a.*) That power be given to municipalities or local Boards to establish, maintain, or contribute to the establishment and maintenance of secondary science and art, technical and commercial or agricultural schools and classes, including museums and art galleries connected therewith under the Science and Art Department.

(*b.*) That the limitation of building grants by the Government to £500 each for science and art be revised, and the grants increased.

(*c.*) That in addition to the Government grants at present made on the purchase of fittings for chemistry, for art furniture, examples, casts and copies, grants be also made on tools for working in wood, iron, and other materials. That in addition to loan collections and the grant of art reproductions at reduced cost, contributions be made to provincial industrial museums of original examples tending to advance the industries of the district in which such museums are situated.

(*d.*) That commercial subjects and modern languages be included in the subjects upon which grants are made by the Science and Art Department. That payments be so regulated as to lead to the encouragement of the teaching of advanced subjects of science, art, and commerce.

(*e.*) That power be given to municipalities by competition, or through the recommendation of head teachers in elementary schools, to provide scholarships, admitting artisan students from elementary schools to secondary technical schools for free instruction.

(*f.*) That power be given to remit the fees of deserving students attending secondary schools, the fees so remitted to be paid by the municipality. That municipalities may provide the necessary funds for taking advantage of the Royal and other exhibitions, under the Science and Art Department, whereby students of exceptional ability are admitted from provincial schools to the normal schools of science and art, and other higher schools or colleges. That special encouragement should be given by such means to the training of teachers.

(*g.*) That each municipality may appoint on its education committee, the Chairman of the Local School Board, the President of the Chamber of Commerce, and such other representatives and friends of education as may hereafter be determined upon.

(*h.*) That municipalities may, if they think fit, and subject to representation on the governing bodies, assist in the provision of accommodation for science and art purposes in existing endowed grammar schools, and in providing scholarships for deserving pupils from elementary schools tenable in endowed grammar schools.

(*i.*) That municipalities may supplement the accommodation provided with the assistance of Government building grants, by the addition of such special accommodation and apparatus as may be required for local trade teaching, such trade teaching to be maintained by the locality, without the assistance of the Science and Art Department.

Municipal Technical Night Schools—

(*a.*) That the secondary and technical day schools established by the municipalities, with their teaching staff and apparatus, be utilised for evening classes.

(*b.*) That municipalities may conduct evening classes *free of charge*, and that the Science and Art Department shall not require the payment of fees from artisans as a condition of the earning of grants, on the subjects on which grants are now or may be made by the Science and Art Department.

(*c.*) That municipalities may conduct, maintain, or contribute to the maintenance of

evening technical classes, in which trade teaching may be imparted.

Existing Technical Schools and Classes in Science and Art, &c.—

(*a.*) That municipalities may, in accordance with the sanction of the trustees and governors of existing technical schools, take over such schools, either by purchase, rental, or gift, to be controlled and administered as if such schools had been built by the municipality.

(*b.*) That municipalities be empowered, subject to representation on the governing bodies, to contribute to the maintenance of existing technical schools and classes, or to the maintenance of day or evening classes in specified subjects, that may be conducted by mechanics' institutions, or similar non-political and unsectarian agencies.

(*c.*) That municipalities, subject to representation on the governing bodies, may establish scholarships admitting students from elementary schools to technical schools under the Science and Art Department, not provided or controlled by the municipalities, and that municipalities may provide the funds necessary for taking advantage of the Royal exhibitions under the Department, enabling students of exceptional ability to be admitted from local schools to the normal schools of South Kensington, or other selected colleges, free of charge.

Technical Schools and Free Libraries.—That it be a recommendation to municipalities, wherever possible, to unite in one building or group of buildings the local technical school, museum, art gallery, and free library.

Higher Technical, Scientific, and Commercial Education.—For masters, managers, works-chemists, and other responsible persons; also for the training of teachers.

(*a.*) That building grants be made to university science colleges on the same conditions as to secondary science schools.

(*b.*) That annual grants for maintenance be made, as at present to the Welsh and Scotch colleges, the amount to depend upon the number of students in attendance, and the provision for their instruction.

(*c.*) That scholarships from secondary schools provided by State and municipal funds be tenable in these university colleges.

(*d.*) That grants be made by the Education Department in aid of elementary teachers who may be trained at such colleges.

General System of National Education—

(*a.*) That the organisation of public education in the United Kingdom cannot be considered satisfactory until public schools are brought into connection with each other by a series of steps leading from primary to secondary schools of the technical, commercial, and classical types, and from these to the modern science colleges or the universities.

(*b.*) That for the effective control and development of such a system of national education a Minister of Education is necessary.

Explanatory Notes.

The above recommendations, if adopted, would enable the municipalities of the country, after the administration of elementary education by School Boards, to establish secondary Technical and Commercial Schools, of the character of those which have done so much to stimulate the manufacturing industries and commerce of other countries, types of which have already been founded and conducted with marked success in some of the towns of England. The schools would be attended in the daytime by students, from 11 or 12 to 17 or 18 years of age, who would receive a practical English education with the addition of modern languages, and supplemented by such art, science, and technical subjects as would be applicable to the wants of each manufacturing or agricultural district. It is to be hoped that a fair proportion of the students would be winners of scholarships from elementary schools. The classes would also be open to young men engaged in local industries, who would be able to obtain specific instruction in science, art, commerce, or technology.

Just as the elementary schools of a district would prepare the scholars for the secondary schools, so from these, by means of scholarships offered to talented students, there would be an open door to the South Kensington normal schools and the university colleges, which would also provide extended courses of higher instruction for employers and others, of greater means and leisure.

Existing technical schools would need to be taken over or assisted by the local authorities, because experience has shown that it is impossible to bring the instruction within the reach of the artisan on a self-supporting basis. Yet it is upcn the skill and knowledge of the artisan that our national prosperity so much depends, and, therefore, the fees must not be too high for the workman who is able and willing to sacrifice his son's earnings by keeping him at school till he is 14 or 15; while, on the other hand, the teaching must be so good that the wealthy employer will find it worth while to

send his son to the local school. The son of the employer and of the workman will thus be found side by side at the same desk, and it is not likely that the mutual contact will injure the one or the other. Just as efficient teaching brings good grants, so it contributes powerfully towards its own cost, and in this respect the financial difficulty of giving to artisans the benefit of the best instruction will not be serious. Nevertheless, any deficiency between the income and expenditure would need to be met by public sources, the most appropriate being the local rates.

School Buildings.

Briefly described, these secondary and technical schools would contain the necessary class-rooms and apparatus for the general instruction of youths intended for the local industries, and so arranged as to be specially available for evening classes. In connection with each school, there would be appropriate rooms for ordinary teaching, adequately furnished for science and art purposes, with exhibition room for pictures, students' drawings and art collections, a museum for technology, &c., a chemical laboratory and lecture theatre. There would also be a workshop for manual instruction, and for the illustration of the principles of science and art as taught in the class-rooms, while in some of the manufacturing towns there would be rooms specially designed for the practical application of science and art to industrial purposes.

State Grants to Technical Schools.

Upon such buildings the Science and Art Department has power at present to grant, at the rate of 2s. 6d. per square foot upon a maximum of 4,000 square feet of space devoted, in each case, to science and art, equal to a total grant of £1,000. For nett class-room space, excluding corridors, I find that 2s. 6d. per square foot represents about one-fourth of the cost of some existing buildings. I would propose that the present limitation be abolished, and that for all new buildings erected solely for science and art purposes, a grant of 2s. 6d. per foot of floor space be allowed, which would represent a State grant of about one-fourth of the cost, excluding land. It is not to be expected that the Department would make any grant upon accommodation for what may be called trade teaching. The aid given by the State would stop at the point where distinctive trade teaching would begin, but localities would be empowered, if they thought fit, to add to State-aided buildings departments for such trade teaching as in the judgment of the ratepayers it might be considered desirable to encourage.

Theory and Practice.

In all technical school instruction, there should be a minimum of practice with a maximum of theory, depending largely upon the industrial facilities afforded to students in each locality. The limitation of assistance which the school may render to the workshop or factory can only be ascertained by experience, and regulated by the demands for artistic and scientific knowledge, which may be made in consequence of the increased industrial efficiency of competing nations.

City Guilds of London.

At this stage I may be allowed briefly to digress in order to suggest that, although State assistance to technical teaching would stop at the point of its application to the several industries of the country, the field would thereby be widened for the great work of the City and Guilds of London Institute, and for the Livery Companies in their individual capacities, to whose munificence technical education throughout the country is already so deeply indebted. Local effort has everywhere been stimulated by the contributions of the Livery Companies, and especially should we remember the splendid gifts of the Drapers, Clothworkers, and other companies to the People's Palace in the east of London, to the Imperial Institute, and, most of all, the gifts of the confederated companies in the City and Guilds Institute, in their erection and maintenance of the Central Institution for the Training of Technical Teachers, the Finsbury Technical College, and the South London Art School. I cannot omit to state that Yorkshire has been placed under a permanent obligation and debt of gratitude to the Clothworkers' Company for their magnificent donations and annual subscriptions to the textile department of the Yorkshire College at Leeds, the Technical College and Schools of Bradford, Huddersfield, Keighley, and other minor institutions, which, through their liberality, have been founded.

Taking up with larger means the work of practical examinations which were initiated by the Society of Arts, the City and Guilds Institute has covered the country with a network of classes from which the best possible

results have already been achieved. The usefulness of the Institute has been seriously retarded because of the lack of preparation on the part of the apprentices and others who have joined the classes. But with a better and sounder provision in every elementary school for the basis of an education suited to the practical needs of our artisans, with manual exercises for the training of the hand, with continuation and night schools for boys and girls, and with systematic instruction in science and art schools by day and night for apprentices and workmen, equipped with efficient apparatus, there will be an ever-increasing army of recruits prepared to take advantage of the trade teaching and examinations of the City and Guilds of London Institute, and worthy of the acceptance of the munificent assistance which the City Guilds are so well able to render.

University Colleges.

The establishment of university colleges is not so much a question for municipalities as for voluntary effort and endowments, supplemented by State aid. A great work is already being done by some of these colleges, and as affording means for the higher scientific training of employers, industrial leaders, talented youths and teachers, admitted by exhibitions from secondary schools, their purpose cannot be over-estimated, and I trust that their means of usefulness will be materially increased under the new Bill.

University Extension and Examinations.

It is also be hoped that the university extension movement, whereby the great endowments and teaching power of the ancient universities are, in some instances, being made available for the benefit of the masses in our large towns, may be still more widely promoted. The experience already obtained must have revealed to the university authorities the enormous field for their labours, and it is only to be expected that, under a system of more adequate preparation on the part of the recipients, it is within the means of the universities to bring the great educational advantages which they offer within reach of vast numbers to whom the possibilities of higher scientific or literary culture would be otherwise unattainable. It is to be hoped also that the Oxford and Cambridge schemes of local examinations may more fully include science, modern languages, and commercial subjects, and become more widely extended.

Imperial Institute.

In another direction there is a new and an untried organisation—the Imperial Institute—which I trust will render enormous service to the cause of technical instruction, in a sense as wide as its name implies. In the nature of things the tide of emigration from our crowded cities and towns must increase, and with it a necessity for more intimate knowledge of colonial requirements and resources. As a "house of call" for colonial visitors; as a great reference and circulating library of colonial information; as a museum of Indian and colonial products, and of British machinery and manufactures suitable for colonial use, I anticipate for it a career of great usefulness; but I hope that it will take up a work of even higher patriotism, viz., the preparing of young men and women for the industrial and commercial development of the rich resources of India and the Colonies, where we all desire that such as leave the mother country will find a home.

I trust that the Institute may be brought into close relationship with the technical schools throughout the country, and that by the aid of bursaries and scholarships, the way may be made easy for students or teachers from the provinces to take advantage of the training afforded by the Institute—not necessarily as intending colonists, but as teachers of colonial wants, in elementary and other schools. In the same way, the Institute may be of great use to colonials themselves.

The emigration question is a very important one in relation to the Technical Education Bill, for it is nothing less than a sin against our country that our people, as too often happens, should be shipped off to our Colonies without the remotest idea or knowledge of the kind of work they will have to do for a living when they get there. In my own travels in the North-Western Provinces of Canada, I was informed by one of the officials charged with the location of the emigrants in the great wheat lands of Manitoba, that during the summer months a train-full of emigrants passed through Winnipeg almost every day from Europe, often to be scattered upon the lonely praries to shift for themselves. Many Englishmen came out with their families, and in starting their colonial life by building a wooden house as a shelter, were often absolutely ignorant of the use of the simplest tools, such as a hammer, a chisel, and a saw, or the ordinary agricultural tools; and in this condition of utter helplessness had to go through great suffering and privations.

The official implored me to do all that I could to bring this humiliating and heartrending state of things before the authorities in the old country. But, as you know, it is nobody's business in English schools to teach boys the use of their hands; the "Code" at present contains no provision for such instruction. I hope, however, that the new Bill will remedy this misfortune, and that the Imperial Institute will also not only open its work-rooms for the technical training of intending colonists but will carry information and advice by means of lectures and inspectors to provincial schools, so that some authoritative knowledge of colonial wants and resources may be imparted in every town in the country. In another direction—the supplying, on the one hand, of provincial museums with colonial products suited to local uses, and examples of such machinery and materials as they buy, and, on the other, the colonial museums with English manufactures, &c., constantly revised up to date—the Imperial Institute would materially tend to keep up the friendly and commercial relations of the scattered Colonies with the mother country.

Technical Night Schools.

Having made suggestions for the establishment, where necessary, of secondary technical schools by municipalities, and for municipal assistance to existing schools and classes, I wish to describe more fully the position and importance which I attach to technical night schools, which I believe will ultimately become the sheet anchor of the whole system of technical instruction in this country. In every department of education in the more advanced continental countries, the Technical Commissioners were almost invariably drawn to the conclusion that the buildings, methods, apparatus, and organisation of instruction were better than our own. When, however, we came to the workshops and factories, and inspected the machinery, and the artisans at work, we were generally able to come to the conclusion that in energy, thoroughness, and general efficiency, in other words, in the factors of production which affect qnantity, we were ahead of our rivals. On the other hand, as I have previously explained, in some of the factors which affect quality and attractiveness we were behind. In a word, I am of opinion that in the ordinary occupations connected with the great industries of this country the Englishman is as much in advance of the foreigner in practice as he is behind in the theory of the lighter and more showy occupations. We have great reason for thankfulness that the main link in our industrial chain—the link of practice—is still sound and strong. But, as you know, it is the weak link which tests the strength of the chain, and here it must be admitted that in the link of theory (and in the giving to an article its showiness or selling quality), we have to take a secondary place. Our work is plainly marked out for us, and must be taken in hand without a moment's delay, and I have no doubt whatever that with day schools such as I have suggested, and properly equipped night schools, this weak link will be effectively strengthened.

The teaching of drawing, elementary science, and practice in the use of tools in elementary schools will give to all our artisan population the basis of technical instruction. The secondary technical and commercial schools will supply such theoretical training as will materially help the class of superior workmen, designers, clerks, and many employers in overcoming some of the difficulties connected with their earlier industrial experiences, besides giving them a wider general knowledge of business. In fact, the day schools, both elementary and secondary, may be compared to nurseries which prepare students, on becoming apprentices, to take up in the evening classes, often of the same schools, the special subjects of science or art connected with their daily industries. Experience has already amply demonstrated that these young men, with nothing to unlearn, can return from the workshop to their familiar class-rooms, and pursue their technical studies with enthusiasm and success altogether unknown to students who have not had the same advantages of preliminary training. There are industries of a highly artistic or scientific character which require special machinery, and for which provision must be made, but to the overwhelming proportion of apprentices the workshop during the day supplies the practice, while the evening class, taught by a practical man, in perfect touch with daily wants, supplies the theory. It is in the combination of science and art with practice which will form the best equipment for enabling our manufacturers and artisans to repel the invasion of the attractive foreign products which fill our shop windows, and therefore I believe that in these technical night schools the problem of technical education, so far as the artisan is concerned, will be successfully solved.

Influence of Foreign Technical Schools.

In no country in the world can this system be carried out so thoroughly, so profitably, and so economically, as in England. The technical schools of the Continent, although the fees are usually low and the teaching is often gratuitous, yet demand great sacrifices of time on the part of the students. Many attend at night, but after 12 hours of toil the brain is in no condition for active or enjoyable study. So the best students, frequently from 18 to 25 years of age, in thousands of instances sacrifice years of practical labour and wages, in order that they may qualify by daily attendance at technical schools to become designers, foremen, chemists, or superior clerks. Having obtained this knowledge, many of them come over to England, and secure the leading situations for which their school training has qualified them, while our own young men, unprepared by scholastic training, have to fall behind into the lowlier and less lucrative positions. Those who remain at home are able to bring their superior training to bear upon foreign manufacturing industries, and thus often give employment to thousands of operatives in making tasteful commodities, whose sale in this and other countries, by depressing the value of our products, takes the bread out of the mouths of English operatives, and steals away the capital of English employers. As was stated by a foreign official, when asked the cost of the technical schools of his country, that he didn't know, and didn't trouble to inquire, for it was England and America that maintained them, by buying the beautiful manufactures and designs which the schools had enabled his people to produce.

Leisure of English Artisans.

The splendid advantage which our artisans possess over those of all others is this, that they have from six to eighteen hours per week more leisure than their rivals, whose competition is pressing us so severely.

But if leisure be not wisely used it may prove a curse and not a blessing, and I regret to say that, at the present time, this advantage is absolutely wasted in hundreds of thousands of instances in this country. There are not a few experienced observers who affirm that, as a nation, we take so much more ease, and demand so much higher pay than our competitors abroad, that we must necessarily be surpassed before long in cheapness as well as in excellence of production. There are others who declare that in the lower wages and longer hours of continental operatives is to be found the secret of our industrial difficulties. To those who have faced the economic facts in the competing countries, the seriousness of such conclusions is this,—that if our wages were reduced to-morrow, and our hours of labour increased to the continental standard, and if even, in addition, our manufacturers and artisans were protected by tariff duties on imports, the nation would still go on importing many millions worth of tasteful commodities from France, and Germany, and other countries, simply because we should not know how to make these commodities ourselves. We have more than enough of the "sweating system" in England already, and while we shall have to continue the fight for cheapness, I am for securing excellence as well. For my present purpose, however, it is sufficient to say that I am less afraid of foreign low wages than of foreign skill, and that we can only retain our leisure by bringing higher skill to our aid in promoting the efficiency as well as the economy of our manufactured productions.

Englishmen not deficient in Natural Faculty.

I have a great respect for the foreign designers, chemists, art workmen, correspondents, and others, whose employment in this country has already done so much to rescue some of our manufactured products and our national trade from barbarity. Like the Flemings of old, who taught us our industries, they are almost invariably good citizens, and men of superior culture. But our position would be healthier, our industrial prospects brighter, and the lives of many of our people would be happier, if these situations were filled by equally capable Englishmen. It is an insult to say that our people are inferior in natural faculties. They are deficient in taste because in their school instruction the training in taste has not been a paying subject under the Code, as may be shown by the fact that, with all our enlightened efforts, three-fourths of the children attending our elementary schools have received no instruction in drawing; and yet this subject was properly described by Sir Henry Holland, when he presided over the Education Department, as "the mainspring of a technical education." You cannot expect art from those who have never learned to draw, any more than you can expect a literary style from those who were never

taught to read and write; and so, with a South Kensington organisation which extends from John o' Groats to Land's End, only about one per thousand of our population are attending schools of art. The testimony of the most competent judges is clear upon this, that whether in art, science, or technical skill, the Englishman is not surpassed by the foreigner when his faculties have the advantage of equal cultivation.

And this brings me back to the kernel of the question, with which I conclude. In our young artisans all over the country we have sources of strength and of usefulness of untold value to the nation, if they were but appropriately developed. I would not deny to them their fair share of cricket, football, and other outdoor recreations, but as it is our patriotic duty not only to shelter them from evil influences but to implant in their minds a desire to be useful, we should use our best endeavours to prevail upon our young men to consecrate a portion of their ample leisure to the cultivation of those intellectual faculties with which they have been endowed. It is in the night schools that our young artisans, after an appropriate foundation in the day school, and side by side with a practical training in the workshop or factory, will learn how to mix their brains with the work of life in which they are engaged.

Free Night Schools Abroad.

When the Technical Commissioners visited the remarkable educational institutions of Paris, we spent most of our evenings in inspecting free evening drawing schools in all branches of technical art, of which we were told that a hundred were spread over the city supported by the municipality. We saw large placards posted on the walls, signed by the mayor, in which he appealed to all young people, as they valued their future usefulness, to take advantage of the classes. When will the Lord Mayor of London bring himself into sympathetic touch with the great neglected masses of London, and issue such an invitation? When we visited Brussels, we made a tour of free night schools accompanied by the Mayor, the Head of the Educational Department, and the Deputy Speaker of the House of Representatives. Whoever heard of Ministers of State and the Lord Mayor of London accompanying a foreign Commission on a tour of free night schools in this great City? I suppose there are many good reasons why such a thing should not happen in the wealthiest and most populous City in the world, but I need only name one, they would not find the schools —at least of the character of the splendid free drawing schools of Brussels—because they do not exist in London, nor in any city or town in the United Kingdom.

The Schoolmaster Cheaper than the Policeman.

It is not for me to attempt to picture the transformation that would take place in London alone by opening Evening Continuation Schools, Recreation Schools, Drawing Schools, and Technical Schools to the neglected multitudes of young people in this great City. The moral effect would, I believe, be indescribable, while, in economy alone, the entrusting of the tens of thousands of boys and girls, and young men and maidens, to the rule of the schoolmaster, the skilful workmaster, and the teacher of domestic economy, would be cheaper to the ratepayers than the rule of the policeman. The latter is employed in restraining the evils of vice—in picking the poisonous fruit from the tree—the former would go to the root, and by inculcating principles of virtue, and habits of usefulness, would stop the poisonous fruit from growing.

I plead for free evening schools, because they would afford a chance of being attended by those who would most benefit by the instruction, and parents and the public generally would thereby take a greater interest in the attendance of their children and in the efficiency of the schools themselves. You may depend upon it that it will be a great thing for this country when in every town a night school is opened, in which poverty prevents no barrier to the admission of the artisan or his child, and in which exceptional talent, even among the humblest, will be unstintingly trained for the benefit no less of the individual than of the community.

It is our belief in the necessity for speedy and effective legislation upon this question of technical instruction which has brought us here to-day. It is not likely that we shall agree upon all the suggestions which I have made, but discussion and inquiry may bring us together. The question is not a matter of mere sentiment or philanthropy, although even in these directions the work presents many attractive features. It is a stern question of practical interest in the means of existence of our population, and in the maintenance of the huge fabric of the State. It may be said that there are no marked signs of decay in our

national condition—and truly our national expenditure gives no evidence of material poverty, although our despairing agriculturists and many depressed traders might illustrate the picture in gloomy colours. Whether you look to our towns, with their growing populations, the costly provision being made for greater health and personal comforts of their inhabitants; the expenditure upon public works; the increase in our military and naval armaments; or upon the private investments in industrial undertakings—all these are remarkable evidences of industrial and commercial success in the past and of faith in the future. But it is not upon our accumulated savings and past prestige that we can rely for future prosperity, but upon our ability to supply our customers with cheaper and better products than they can obtain elsewhere. The wealth of the State comes from the labour and skill of the people, and the State has no higher concern than in sanctioning and in contributing to the appropriation of what may be necessary of the national income towards promoting the scientific and artistic efficiency of those by whose taxes the income is raised. The recognition of this duty is amply acknowledged, and we respectfully urge that it may be as promptly performed. I remember being much impressed by a remark that was made by the late Mr. Forster. He had piloted through the House of Commons the great Education Act of 1870, which will be for ever associated with his name, and he said, "England is often late, but not too late." We are late now in taking up in a national spirit this great question of technical instruction. I pray that the warnings we have had may not be unheeded, and that in the diminished employment and the suffering of our people, the cry may not come back upon us that "England is too late."

DISCUSSION.

The Chairman said this was a most interesting paper, and he thought all present would be glad to know that it had been decided that the discussion upon it should be continued on the following Wednesday, when he hoped Sir Bernard Samuelson, the chairman of the late Royal Commission, would be present, which he could not be on that occasion, having to take the chair at the Associated Chambers of Commerce. Anyone who had not before appreciated the importance of this subject must now be in a position to do so. It was perfectly clear that the country had now made up its mind that something must be done, and the main points to be aimed at were—in the first place, to formulate their views as to what was wanted; and, secondly, to consider how it was to be obtained. It would be as well to put on one side the notion that, to establish technical schools in various localities was all that was needed. The ignorance on that subject, both on the part of those who ought to know better and of the working classes, was astonishing. It had been made clear that a division had to be made, that elementary, secondary, and higher schools, or technical institutions, were needed; and it was also certain that the method of training in each would be different, and the mode in which they were founded and supported, whether by voluntary effort, local authority, or municipal aid, might also differ according to the condition of the institution and the wants of the locality. In discussing the Bill of last Session, Mr. Smith had pointed out that something further was now required, and that they would not be satisfied to allow a clause, such as he referred to—providing for a *plébiscite*—to pass this year. He could not see why other great English cities were to be treated on a different footing from the metropolis, or why any part of the country should be treated differently from the more fortunate inhabitants in this respect, as in the northern part of the island, and he thought the House of Commons would be much to blame if any such clause were passed. A good deal of discussion had arisen with regard to handing over the technical instruction of the country, so far as payment of results was concerned, to the Science and Art Department, but it seemed to him the position taken up might well be defined, and that the words used by Professor Huxley were very applicable when he said that "people must be extremely sanguine if they suppose the House of Commons or House of Lords will ever permit of giving any locality unlimited power to tax the inhabitants of a district for anything they please." The position taken by the last Bill, therefore, that technical instruction—which was no doubt difficult to define exactly—meant instruction in branches of science and art, with respect to which grants were, for the time being, made by the Science and Art Department, or any other subject which might, for the time being, be sanctioned by the Department—he thought was correct, and the expression "technical school" should mean a school, or a department of a school, giving technical instruction to the satisfaction of the Science and Art Department. Amongst the provisions of the Bill of last year, this was one which might be well accepted and welcomed by all friends of technical instruction. The question of technical instruction in primary schools was comparatively simple, and they would probably get a Bill this year on somewhat similar lines to those now laid down, under which authority would be given to School Boards, or where they did not exist, to the local authority, to rate the district for the purposes of technical education. But even here there were points on which some difficulties

might arise. How were the large number of voluntary schools to be paid for? Was the School Board to pay over to those schools a portion of the rate, or was that to be obtained through the municipality? That question would have to be decided. Of the importance of continuing evening schools there could be no doubt, and all who took an interest in the subject would agree that this was the key of the position, so far as the artisans were concerned. One point to discuss was whether these schools should be free; and on that he entirely agreed with Mr. Smith. Then the deficiency which would no doubt occur would have to be defrayed, in the case of Board schools, out of the School Board funds; but the question would again arise with regard to the voluntary schools. How were night schools, under the voluntary system, to be paid for if they were free; and he believed in Liverpool, that about two-thirds of the schools were voluntary. Coming to the question of secondary teaching, that was more difficult, because no organised system of secondary education exists in the country, and the great cry now was for such an organisation. The forthcoming Bill ought to contain a provision that municipalities should have the power of giving funds for the support of secondary technical schools in their districts. Some day there might be a general educational authority, who would take all educational institutions under its command, and that was what we must all wish to see; but at the present time the School Boards had nothing to do with secondary education, and could not give assistance to it. How, then, were such secondary technical schools to obtain grants? If they did not obtain assistance from some source, either from the Imperial Exchequer or from the locality, they would soon cease to exist. He was pleased to see the special importance attached to the teaching of modern languages, for it should be remembered that this was as much technical training as any kind of handiwork. Mr. Smith had pointed out the necessity not only of having elementary night schools in connection with the Board schools, but also secondary night schools in which the education of apprentices and persons occupied during the day should be continued or provided for. Every one must appreciate the value of that, especially those who, like himself, had had the advantage of visiting these schools on the Continent, and seeing what an enormous influence they exercised on the art and industries of the countries where they existed. The suggestion that in these schools no fees should be taken by the Science and Art Department from artisans was a very proper one, but of course the deficiency would have to be made up by the locality. Whilst looking to the continental schools, and seeing what the system had done to promote the industries of those countries, he thought they should be careful not to absolutely imitate continental methods. We in England had certain growths of our own, which we ought to foster and develop, and whilst benefiting by the experience of other countries, it would be the greatest mistake to servilely copy either the French, German, or other continental models. With regard to higher technical instruction, having been long attached to one of the large colleges in the north of England, he need not say what importance he attached to the highest of all technical instruction the application of the principles of science and art to the fullest possible extent. This was especially developed in Germany and Switzerland, and might be illustrated by an old story which would, however, bear repetition. In Zurich there had been established for some thirty years a Polytechnic School, which had done a great deal in improving the arts and manufactures of the country. A country which, though so small and having no seaboard, so that the mere transport of its cotton from Alexandria, London, or Antwerp, added 2d. a pound to the cost of manufacture, was yet able to compete in yarns, cotton, cloth, and printed goods with Lancashire and Scotland. This technical school was founded as a federal institution, and a few years ago it was proposed by the Minister of Education that a new chemical laboratory should be built, at a cost of £74,000. This was a little startling to the members of the Bundesrath, who probably were not so well up as some of our own statesmen in the advantage of scientific instruction, and they rather objected to pay this large sum. This was not very surprising, and he should rather like to see the faces of members of Parliament on either side of the House if it were proposed, even in London, to build at the public expense a chemical laboratory which would cost £74,000. There was, accordingly, in Berne, some opposition, but the Minister of Education pointed out that the amount of money which had already been received by Switzerland from the men who had studied in the Polytechnic School in Zurich, and who had founded works of different kinds in Switzerland, had paid ten times over the amount he was asking for, and that this money would be well spent, and would, in a short time, be recouped. With regard to the Science and Art Department, he understood that in some parts of the country there was an amount of jealousy and want of appreciation of the Department, but he had had a great deal to do with it, and from his own experience, and comparing the work it did with that accomplished by other institutions, and by other classes of persons—and he had had opportunities of judging of what was done, both in the universities, old and new, and in a large number of the highest class of schools in the country—he must say that the examinations of the Department were conducted with a care and exactitude which was nowhere excelled, and that the work done in many cases was most excellent. One could not expect a boy taken out of the ordinary schools, and taught the elements of chemistry or other branches of science for nine or twelve months, to show proficiency in the subject; people had to study it for years, and then did

not become proficient, but the little they knew was, as a rule, real knowledge, and it showed the falsity of the old proverb that a little knowledge is a dangerous thing. A little knowledge, when sound as far as it went, was not dangerous, but useful; it was only the little knowledge which was incorrect, or when the possessor fancied he knew a great deal more than he did, which became dangerous. Now, these science classes did what they profess to do—they gave a certain amount of sound knowledge spread all over the country, and in no other country would any system of similar character be found. He would also endorse emphatically what had been said with regard to the City Guilds of London. The example they had set and the work they had done was beyond praise, and he hoped they might be grateful, not only for what had been already done, but also for like favours to come. Technical training was intimately connected with science and art training, and as the importance of this question became more fully recognised, and the demand for this kind of training became greater, it seemed to him that some kind of co-operation between the system of education and examinations established by the City and Guilds Institute, by the Guilds themselves, and those carried on by the Science and Art Department, would be very desirable. The Government were, in fact, already instituting examinations in really technical subjects; for example, metallurgy, building construction, which belonged to applied science, or technology—not to pure science. It would be very difficult to draw a line between the subjects examined in and paid for by the Government Department, and those examined in and paid for by the arrangements now existing under the ægis of the City Guilds. The question of the control and direction of the technical education of the country was most important, and, like the elementary scientific and artistic education, must, in his opinion, sooner or later, fall into the hands of a department of Government answerable to Parliament for its administration.

Mr. Samuel Smith, M.P., said he was much gratified at meeting Mr. Swire Smith, with whose writings on this subject he had long been familiar, and he always found them marked with a perspicacity and practical knowledge which he often missed in other authors. That probably arose from the fact that, on the one hand, he was himself a man of business, and knew what was practically required, and, on the other, he was endowed with a scientific frame of mind. Hitherto, education in this country had been principally in the hands of theorists—often very able men, but still somewhat pedantic, and very unpractical. England had groaned under education conducted by theorists for centuries, and as a consequence, we had been much behind other nations on the utilitarian sides of education. He was very pleased to see the ideas which he had been ventilating in Liverpool for the last ten or fifteen years coming to the front. Upon the higher branches of technical education he was no authority, but he had paid a good deal of attention to the question of elementary continuation schools, and to that point he would confine his remarks. He had been painfully cognizant of the deterioration of the children who passed through the elementary schools in the few years that immediately succeeded their school life, and having had a good deal to do with the various rescue works for children, including emigration schemes, he had come to know a great deal of the habits and manners of English children at the period of life he had referred to. Every succeeding year it had been pressed upon him with increasing force that a great portion of the social difficulties which seemed much greater in England than in any other country, arose from the neglect of the children after they left the day-schools. Wherever he travelled he had always been a close observer of social questions, and he found nowhere anything approaching to the waste of human material which went on in England. In the City of London, if you could trace the lives of the half or three-quarters of a million children who attended the elementary schools, it would be found that an enormous wastage took place in the three or four years after leaving school; he should not be surprised if 25 per cent. lost all they had gained in their elementary education, and not only that, but they became corrupted, demoralised, and unfitted for a life of industry to a degree he had seen in no other country in the world. Last autumn he made a tour through Germany and Switzerland, for the purpose of studying practically the elementary educational system there, having known it theoretically pretty well before, and he came back impressed with the belief that Germany was 100 years ahead of us in this respect, and especially in the care taken of the young. In English towns like Liverpool, Manchester, or London, the streets of an evening swarmed with juveniles, and so did the public houses and low places of amusement, but in a German city the streets were as quiet as ours in the middle of the day; you never saw children in masses anywhere, they were all at work. The whole child population was in some shape under discipline and training for the most part up to the age of 16 and 17. In that way they were tided over the period when they had no sense to conduct themselves, were accustomed to work, and became hardworking, sober, and temperate citizens. In England the same class were, to a large extent, going to ruin. His belief was that any scheme of technical education which merely provided for youths of 16 or 17 and upwards would scarcely touch the fringe of this question, unless it were united with a system of evening continuation schools, to carry on the children from 12 or 13 to 16. Children would not come to a technical school at 16 if they had been running wild for three or four years; by that time they would have lost all power of application, and have become utterly uncontrollable. The reason why

there was such a large number of intelligent youths in the higher technical schools in Germany, was because their taste for education was kept up by means of the continuation schools, which they were compelled to attend. He thought it should be made obligatory on children to be under some sort of training in evening schools up to the age of 15 or 16, and then, by the next generation, half of the crime, destitution, and drunkenness, which was the curse of our country, would be cut off. He had been much in contact with the destitute classes, endeavouring to raise them, by emigration and various other means, and he was satisfied that nine-tenths of the social misery in London, represented in Trafalgar-square for several weeks, was incapable of cure, owing to defects of education. No method existed by which that mass of human helplessness could be converted into good material, because in early life they had learned nothing of the slightest service to them. They could not use their hands or their heads, and had no power of application, and they were fit for nothing in a new country. He had tried various experiments in many ways, but they had mostly failed. There was now an excellent system of elementary education, so far as it went, but it let the child go at 12, in the rural districts often at 10; and after 12 or 13 not more than 1 per cent. continued their education in any way. Evening schools should be established for this class, and they should be compelled to attend them up to the age of 15. In Germany they were carried out to 17. Half-timers might now begin at 10, but he would raise the age to 12, and none should be allowed to work full time until they were 15. These evening schools must be largely of a technical character, training the hand and the eye, which had been terribly neglected in this country, as much as the mind. It would be quite possible to render them so interesting and useful that very little compulsion would be required. This was the scheme he had been labouring at for some years, and he was glad to find that others were now coming round to the same way of thinking. Such schools, he thought, would come more properly under the Education than under the Science and Art Department, which should begin with the proper technical schools for lads of 16 or 17.

The discussion was then adjourned to Wednesday next.

Miscellaneous.

GEOLOGICAL MAPS.

In 1802 the Society of Arts offered the following premium :—"To the person who shall complete and publish an accurate mineralogical map of England and Wales on a scale not less than ten miles to an inch, containing an account of the situation of the different mines therein, and describing the kinds of minerals thence produced, the gold medal or fifty guineas." There were at this time county "maps of soils," issued with the reports of the Board of Agriculture, but the facts indicated on them are of a very different kind from those now given on geological maps. No published geological map of any kind existed, though before 1801 William Smith prepared a small MS. map of England and Wales (now in the possession of the Geological Society), which he was endeavouring to get published.*

The offer of this prize was continued until 1814? and in June, 1815, fifty guineas was awarded "to Mr. William Smith, of Buckingham-street, for a coloured fifteen sheet mineralogical map of England and Wales, on a scale of five miles to an inch."

In "Transactions of the Society of Arts," vol. xxxiii., preface, p. vii., is the following :—"Under the class chemistry will be found an account of a most valuable mineralogical map of England and Wales, a labour of many years by Mr. William Smith, in which he has, with infinite care and accuracy, pointed out the situation of the different strata of coal, lime, iron, stone, and other mineral products, and the cheapest means by which these useful products may be brought to market. The Society have presented him with fifty guineas." In the correspondence and official certificates about the map it may be seen at p. 51 that Smith drew attention to the fact it was on a scale double the size required by the Society.

The steps by which that map became the foundation of our present geological survey maps have to be traced by reference to different scattered records, and it is interesting to observe how the Geological Survey has in late years taken in hand a re-survey of the country, for the purpose of mapping the post pliocene beds, which have so much influence on the industry, the furtherance of which Mr. Smith, at the outset of his career, chiefly had in view,

* It is not now known whether the Society was aware at the time of the existence of this MS. map. Smith's method of mapping was first shown on his MS. Environs of Bath, 1799. In 1803, he had an office in Craven-street, and in 1804, in consequence of a fire, moved to Buckingham-street. Here he kept his papers, &c., though till June, 1805, his fossils were still at Bath. In 1804, through the introduction of the Duke of Bedford, he explained to the Board of Agriculture the progress he had made in the maps of the strata, and in the principal applications of geological science to agriculture. In 1805 he received from the Society of Arts a medal for the application of his geological knowledge to the drainage of Prisley Bog, as described in his "Treatise on the Construction and Management of Water Meadows." The nature of the work that was occupying all his energies must therefore have been well known (Sir Joseph Banks, P.R.S. took much interest in it from 1804, onwards), yet it was not till 1815 that successful arrangements could be made for publication. Debrett (Piccadilly, opposite Burlington-house), who, in 1801, undertook to bring out a small map, met with misfortune in his own business. It was Carey who, in 1815, brought out the map on a scale of five inches to a mile, in fifteen sheets (size 8 ft. by 9 in. by 6 in. 2 in.), having taken the work in hand in 1812. This is the map for which the premium was given.

namely, agriculture. The Council of the Society had regard rather to the mineral wealth of the country.

The idea of an official geological survey appears to have originated nearly thirty years before any actual steps were taken to give it effect, for in the year Mr. Smith received the premium a letter was presented for preservation by the Society, written to him by Mr. R. Crawshay, of Merthyr Tydvil, December 27th, 1805, in which he says, "I like Sir John Sinclair's idea of uniting you with the corps of surveying engineers." This was at the time the Trigonometrical Ordnance Survey was in progress, and Sir John Sinclair's wish was that Mr. Smith should be attached for the purpose of connecting his survey of the strata with their larger maps. This idea was, however, not carried out.

Before 1832, Mr. (afterwards Sir) Henry De la Beche had, at his own cost, undertaken a geological survey and map of Cornwall. The importance of this to mining industry was impressed on the Government, £300 per annnm was allowed, and two civilian officers were attached to the survey. From this, under De la Beche's care, H.M. Geological Survey was gradually established.*

In 1832, it became necessary to adopt some authorised colouring for the different strata, and in the Survey-offices at Jermyn-street is a MS. list for the colours to be used for sheets 21 to 27 (the Devonshire sheets). There is this memorandum:—"These colours are the same as those at present adopted by G. B. Greenough, Esq., for the second edition of his geological map of England and Wales preparing for publication." The Greenough map has on its title "based on the work of Wm. Smith." Except for the omission of the stronger colouring, at the outcrops, the method followed by Smith was thus handed down to the geological survey, viz., that of mapping what is called the "solid geology," irrespective of the "superficial deposits" whatever their thickness, and also of using those colours to represent the area occupied by the different strata, which somewhat corresponded with their natural colour, though modified for the sake of distinctive contrast. A reference to the successive editions of the sheets called the "Index to the signs and colours" used on the maps, gives a good generalised idea of the progress of the detailed knowledge† of the subdivision of the different strata. They were issued in 1833 (?), 1848, 1856, 1865, 1867, 1869, and 1874, the colouring and signs looking more complicated, but giving more information, as knowledge increased with experience.

Before the whole of England had been surveyed for the "solid geology," which was done in 1884, it was seen that maps showing the "superficial deposits"*—drift maps they are called for shortness—would be of value for many purposes, especially for agriculture. To have a map of the "solid geology" of a district, when the strata are covered by 30, 50, 100, or more part of drift, could be of no great value to the agriculturalist. Although Mr. Smith made no attempt to map these superficial deposits, it was not because he was unaware of their existence. In several places he alludes to the difficulty of tracing the boundaries of strata owing to their being so covered up, and, considering how entirely new was the subject at which he was working, he indicated with great clearness the distinction between alluvium and solid strata. This is not only referred to in many of his travelling notes, but was a distinct point in his York lectures in 1824. That some of his "alluvium" was of glacial origin he neither knew nor was it suspected by any English geologist till long after. He noticed, too, that the fossils in the "alluvium" retained their own properties, and "were not changed into the materials of the strata in which they were found." That he should refer the alluvium to the Deluge was due to the views held at the time, but he sagaciously draws a distinction between the fossil remains of the "solid strata," too deep to have been affected by the Deluge, and those of the alluvium.

As knowledge concerning this "alluvium" advanced, it became possible to map it on some definite plan, and the word itself came to be used in a restricted sense.

In 1848, the only recognised divisions of superficial deposits were blown sand, alluvium, shelly beds, gravel, but at this date the survey was mostly confined to the south-west of England. In 1865, there appeared for the first time a distinction into "glacial" and "recent and post-glacial." The post-glacial was grouped in three divisions, subærial, freshwater, and marine. The sub-divisions of the marine were "shingle," recent marine, raised beaches, and of the freshwater the sub-divisions were alluvium (the word here being used in a restricted sense), lake deposits; old river alluvium (brick, earth, and "warp"); old river gravel. Then of glacial, moraines; sands, gravels, brick clays; upper erratic boulder beds; and and gravel; lower boulder beds and till; forest beds. Though it may not interest an agriculturalist to know whether the soil on his land is of marine or glacial origin, a knowledge of the area occupied by any bed is of value, for some are nearly constant in their character while others are very variable within short distances. An inspection of some of the

* It remained under the Ordnance Department till 1845, when it was transferred to Woods and Forests. It was again transferred in 1854, being then placed under the Science and Art Department, as it still is. De la Beche remained director till his death in 1855, when he was succeeded by Sir Roderick Murchison.

† Much of the knowledge was the result of work done by fellows of the Geological Society, not on the staff of the Survey.

* Sir R. Murchison, in his report for 1863, mentions that having given direction that there should be prepared "maps of the superficial deposits (agricultural maps in point of fact), it became necessary to go back over certain areas, and insert the superficial drift of gravel, &c., which it had not hitherto been usual to map." It was fourteen years after this that any of the maps were actually ready for publication.

eastern counties maps shows how very complicated the drift geology is in some cases, while in others a large area is uniform, *e.g.*, the Stowmarket sheet (50 S.W.) is nearly all boulder clay.

The last published index to signs and colours, 1874, shows the still greater accuracy into which the post-glacial deposits are divided. The glacial grouping remains the same, but for post-glacial the following was then substituted:—Blown sand; shingle; alluvium; river terraces, 1, 2, 3, &c.; peat; warp, and lacustrine sands and clays; burtle beds; brick earth and clay with flints (on chalk); brick earth, of 1, 2, 3, &c., river terraces; gravel of 1, 2, 3, &c., river terraces; post-glacial gravel and sand; post-glacial brick-earth. This sequence is from above downwards, and then follows, below, the glacial. Some of these beds occupy such small detached areas they would escape the attention of any but an experienced geologist, but while they might be overlooked by the agriculturist, they have an influence, both direct and indirect, on the value of his land, direct where the soil is used as it is, and indirect where an artificial mixing of soils is of importance. It is admitted that though other countries are before us in the actual production of maps, no nation surpasses us in the accuracy of our geological survey.

Before 1880 there were but about half-a-dozen drift maps published (the date of one or two is not given), but many were issued between 1881 and 1884. By 1885 there were 110 ready, or nearly ready. The present state of the drift survey may be roughly explained in this way, that the maps are published for the whole of England, north of a line drawn from Brighton to Liverpool, except for some of the midland portion. Most of the sheets are accompanied with short descriptive memoirs, which furnish information about the character and thickness of the beds, while all details of well borings are, as far as possible, collected and recorded. There are also many horizontal sections, drawn on true scale, six inches to the mile, and vertical sections one inch to forty feet.

When the survey was commenced, the Ordnance sheets (one inch to mile) were used, but in 1856 Murchison urged that the six inch to the mile should be adopted whenever the Ordnance maps on that scale were ready. The geological maps of the six northern counties have been issued in that form, but the publication of others has for a while been suspended.

MINERAL WEALTH OF THE CAUCASUS.

The *Revue Universelle des Mines* states that there is hardly any portion of the globe so rich in minerals as the Caucasus. Throughout the whole of that vast territory known as Transcaucasia, from the Caucasus chain on the north to he Persian frontier on the south, and from the Caspian Sea on the east to the Black Sea on the west, minerals and ores abound in great profusion. In this connection, the Government of Yelizavetpol deserves especial mention. It constitutes one of the richest provinces of ancient Armenia, the subsoil of entire districts being composed of a very rich copper ore, containing as much as from 10 to 20 per cent. of metal, and which crops out in numerous places. Other ores, not less valuable, are frequently to be met with, more particularly the argentiferous galena, containing as much as 17 per cent. of silver, and 60 per cent. of lead. There exist in the same district important deposits of iron ore, and cobalt is also found. Iron ore in different forms abounds also in the government of Tiflis, at Tchatah, in the districts of Charopa, Katchan, and at Batoum, where argentiferous copper ore is also found in considerable quantities. Iron is found in Mingrelia, and in the bed of the Ingour stream. Oxide of manganese exists in very large quantities in the governments of Koutaïs, Tiflis, and Yelizavetpol, but up to the present time it has only attracted any serious attention in the valley of Kvirilla, which is situated in the government of Koutaïs. The government of Erivan possesses, in addition to many valuable ores, large quantities of rock salt. Sulphur is found in many localities, particularly in Daghestan, where it is regularly worked, Deposits of zinc, antimony, saltpetre, soda, marble, gypsum, ochre, lithographic stone, fire-brick, ozokerit, &c., also exist in various parts of the country. One of the most important elements of the wealth of the Caucasus consists in the well-known naphtha springs of the province of Apchérou, near Baku, and there appears to be every indication that this product will be obtained in considerable quantities on the borders of the Black Sea, between Poti and Batoum, near Ouzourgeti. To properly develop the mineral wealth of the country two things are necessary, an abundant and cheap fuel, and facilities for transport. The country itself is traversed by the railway connecting Batoum and Poti with Baku, and the districts which are richest in minerals are situated at a distance varying from ten to fifty miles from the line. Well-made roads communicate with the railway, and there are numerous waterways. The cost of transport by cart or on the backs of animals is not excessive in the Caucasus, particularly in the eastern districts; for small quantities it is estimated roughly at about thirty centimes per ton and per kilometre. As regards fuel, it may be observed that if the western portion of the Caucasus is exceedingly well wooded, the eastern part is not so favourably situated. Wood, however, is not indispensable, as the country possesses a valuable fuel in *astatki* or *mazout*, residue of the distillation of petroleum. The heating power of the product is greater than that of coal, and its transport is easy. There are besides some important coalfields existing at Tkvibouli, in the government of Koutaïs, which are expected to produce coal in sufficient quantities to meet the requirements of the country. Labour is cheap in the Caucasus, the average price per day in the large cities and the plains being from

about one shilling to one shilling and three pence. In the mountainous districts of Yelizavetpol and Tiflis it is even cheaper than this, being at the rate of about sevenpence to eightpence per day.

SPECIE MOVEMENTS IN INDIA.

It may be of some interest, with reference to the remarks which have so often been made on the practically unlimited capacity of India to absorb the precious metals, to show what that capacity has actually been.

In the 14 years ending 1873, the net imports of gold (deducting exports from imports) were in round numbers £72,606,223, or an average annual import of £5,186,158. In the 14 years ending April 1887, the net imports were £34,830,613, or an average annual import of £2,487,910, which is less half the annual imports of the first period. It may be noted, however, that the average of the second period was greatly affected by the remarkable diminution in imports during the famine period of the three years 1876 to 1879.

The total net imports of silver into India in the 14 years ending 1873, were to the extent of £117,224,224, and in the subsequent 14 years only £91,581,118. The capacity of India for the absorption of silver does not seem to have been nearly so great in the last period as in the previous 14 years, and yet it is remarked by Mr. O'Connor, the Assistant-Secretary to the Government of India, in the commercial department that with a largely increased population and vastly increased progress in railways and other public works, and in the volume of commercial transactions, it might have been supposed that to maintain an adequate currency, the supplies of silver should have also largely increased, especially if it is true, as some think, that silver has depreciated in value, and that therefore India can afford to buy more of the metal. The fact that India has not been able to buy as largely of gold as it wishes, owing to the appreciation in value of that metal, is clear enough from the figures above given, and the converse result would have taken place, no doubt, with silver if it had really fallen in value, and if the wants of India in respect of the metal had not been fully satisfied. It is difficult to say, indeed, that those wants have not been fully satisfied, for the value of the rupee in India is still not much less than it was twenty years ago over the greater part of the country. Prices and wages have materially risen, locally where a large and sudden demand for labour or commodities has arisen, or where railways have tapped regions which previously had no external markets; but taking a general view of the whole country, it does not seem that there has been any such general or considerable rise in prices as to indicate that the currency is redundant. On the other hand, there has been an enormous increase of manufacturing industry, of railways, and other public works, or transactions in both the internal and external trade, and it seems reasonable to conclude that, making all allowances for the displacement of metal by currency notes, bills, drafts, and cheques, the employment of silver must have increased in at least double the ratio of increase of the population. The imports of silver, however, have actually not increased since 1873, when the relative values of gold and silver began to diverge considerably and increasingly. Therefore the theory that, there being no place for silver in Europe and the United States, the increased production of the mines, and the unusable stock withdrawn from currency, would be taken up by the East, has not been verified by the facts. The coinage of the Indian mints, too, has not increased, the average coinage for the 14 years preceding 1874 having been 700·3 lakhs a year, and in the fourteen years since then 621·7 lakhs.

It is evident that the increased supplies of money required for the increasing needs of the country have been met from internal sources of supply, and the only inference that can be drawn from the facts is that old hoards have diminished, metal having been taken from them for circulation as coin, and that now hoards are neither quite so large nor quite so common as they used to be—in fact, that the practice of hoarding is gradually, though slowly, falling into disuse, and that the silver imported into India goes every year more largely into circulation. India is no longer such an abyss as it was in former days for the absorption of silver, and for its withdrawal from currency.

TOBACCO CULTIVATION IN MEXICO.

The manufacture of tobacco in Mexico into cigars and cigarettes is of comparatively recent origin dating from the Cuban insurrection of 1868, when a number of refugees from that island landed in Vera Cruz, and there established factories for the manufacture of cigars and cigarettes of the tobacco of the country. Since that time factories have been established in all parts of the Republic where tobacco is produced, and the tobacco industry is now, it is stated, furnishing employment for many labourers and skilled workmen. Vera Cruz, says Consul Mackey, of Nuevo Laredo, contained in 1886 four important factories for the manufacture of tobacco, "La Union," "La Especial," "La Prueba," and "La Nacional," besides various establishments on a smaller scale. These four factories employ among them more than a thousand workmen. In San Andres Tuxtla, there are ten factories of the first order, three in Jalapa, and many in Orzaba, Puebla, San Louis Potosi, the city of Mexico, and elsewhere. The factories produce cigars of all qualities, ranging in price from £4 to £40 per thousand. Cigars are manufactured of every size and every shade, and it is

said that great ingenuity and taste are displayed in devices of shape and ornament to attract the eye of the smoker. The Valle National, situated between the States of Vera Cruz and Oaxaca, produces tobacco of the finest quality, and is entirely devoted to that purpose. The tobacco of San Andres Tuxtla, Acacuyan, Jathpam, and other portions of the same region, is of excellent quality. Tlapacoyam produces large quantities of tobacco of a class inferior to that grown on the Gulf coast, although the wrappers of Tlapacoyam are much esteemed for their smoothness and fineness in texture. Tobacco of an inferior quality is raised in Orizaba, Chiapas, Cordova, and Oaxaca. The price of tobacco in the leaf, for wrappers and filling, varies in different localities, ranging, for filling, from four to fifteen dollars, and for wrappers from ten to thirty dollars the arroba of twenty-five pounds. The lands especially adapted to the cultivation of tobacco, the best *vagas* as they are termed, are low, situated in valleys or on the banks of rivers and of easy irrigation. Frequent rains and a humid atmosphere are valuable agents in producing abundant and good crops. In cultivating tobacco in Mexico the following is the method of procedure—the ground is first broken with a species of hoe, and ridges are formed for the reception of the seed, of sufficient breadth to admit of their being cleaned with facility. The stubble is burned or removed, and the trenches are then opened or cleared, in order that the water used in irrigation may circulate freely. The soil having been moistened, a clear day is chosen for sowing, which is done broadcast, care being taken to scatter the seed evenly and equally. In some localities the seed is mixed with fine sand or ashes, which are said to protect it from the attacks of certain insects, and to promote the growth. The shoots sometimes appear in from eight to ten days. Where rain is scarce it is necessary to water the plants, which should be done early in the morning, or in the evening. The shoots are ready for transplanting when they have attained the size of the ordinary lettuce. In their removal, attention is given that the earth adhering to the roots of plants should not fall upon the leaves of others, as this produces a disease called the *pulguilla*, staining the leaves, and destroying the active principle of the tobacco in those places where it is deposited. The season for transplanting, like that for sowing, varies according to the climates of the respective localities, it being sought always to gather the crop before the arrival of the frosts. The ground is subject to several ploughings, at intervals of from ten to twelve days, and the ditches are opened by which the fields are irrigated. That the excessive humidity of the soil may not injure the plants, they are set either on the ridge or in the side, and not in the middle of the furrow. A hole is made for the reception of the plants by means of an iron instrument, and in each receptacle is placed a plant, or two if they happen to be feeble. If the heat of the day is not excessive, those who set out the shoots follow immediately the labourers who open the ground with their iron planters. For this reason cloudy days are preferred for transplanting. In setting out the shoots the earth is pressed carefully around the roots, and levelled, so as to leave no inequality where water may settle. About 20 days after the transfer of the plants, the fields are weeded, and plants which have withered or died are replaced by others of the proper growth. When the plants have attained the height of from fourteen to sixteen inches, the lower leaves are removed, and fresh earth is packed about the base of the stalk. The next operation in the cultivation of tabacco is the *capazon*, or pruning of the plants, which consists in cutting away the tops to prevent florescence. This is said to be an operation of such delicacy, that upon the skill with which it is performed often depends the good or bad result of the crop. According to the authorities in tobacco culture, the *capazon* is made by grasping firmly the stem of the plant, so that in cutting upward the roots may not give way, and then with a knife removing the top above the joint, where the last leaf joins the stem. The two or three lower leaves are cut away, for these are worthless and absorb the sap to the prejudice of the others. When the leaves arrive at maturity, they become smooth and lose the down with which they are covered. They are then gathered, and this operation is effected on clear days and after several hours of sunshine. After the leaves are harvested, the plants are cut six or eight inches from the ground, the earth is again loosened about the roots and watered afresh. Thus a second, and often a third harvest is obtained. In curing, the leaves are subjected to several processes before being sent to the factories. After being spread in the sun for some time, they are strung together and suspended in a house constructed for the purpose. In order that the fermentation should not be too rapid, the leaves are not allowed to touch each other. After three or four days, the leaves are separated and allowed to dry slowly, it being desired that the colour of the veins or stems should be the same as that of the other portions of the leaf. In the process of curing, the leaves perspire, and it is necessary that the curing places should be well ventilated, and that excessive heat should not produce such great fermentation as to be injurious. After the curing is completed, the leaves are separated and distributed in classes according to the custom of the locality; they are then packed for market. If after packing the slightest fermentation is noticed, the bales are re-opened and exposed to the air until all fermentation disappears. When the leaves are too moist they are exposed to the danger of rotting in the bundles; if too dry, they want flexibility, and break in the process of manufacture. Consul Mackey says, in conclusion, that the tobacco of Mexico is of such excellent quality that it is said by many to equal that of Cuba, and there is no doubt among those acquainted with Mexican tobacco that such a comparison is admissible.

DYE WOODS OF THE ARGENTINE REPUBLIC.

Consul Baker, of Buenos Ayres, says that the principal dye woods of the Argentine Republic are the *Quebracho colorado*, the *Algorrobo blanco*, the *Corovillo*, and the *Lapacho*. By boiling the sawdust or shavings of the red *quebracho*, a dark-brown liquid is produced, which, being evaporated to dryness, and cooled, produces an almost black substance, brittle, and of a certain lustre, but with which, it is stated, no chemical experiments have been made. For this reason neither its exact chemical composition nor its physical properties are perfectly known, but from its appearance it is very similar to the matter which has long been known to commerce as "dragon's blood." The extract of *quebracho* is used alone to dye wool, as also with such mordants as alum and copperas, or sulphate of copper. In the bark of the very old *Algorrobo blanco* trees a brownish-black sap sometimes runs down, which impregnates it with a resinous and gummy substance that completely dissolves in hot water, thus forming a dark brown tint very similar to the extract of *Quebracho colorado*. By detruncating the trees of the very largest size, a black and extremely bitter sap exudes from the tree, which gradually solidifies in the air. The aqueous extracts made from boiling the wood, and then evaporating to dryness, do not solidify on being cooled so perfectly as those of the *Quebracho colorado*, but form delicate, viscous, and somewhat tough superficial laminæ. The solution of the colouring matter of the *algorrobo*, without recourse to any mordant, produces very fast colours, not only in wool and silk, but also in cotton and linen goods. The colour varies from the clearest to the blackest brown, according to the application. Both the bark and the wood of the *corovillo* appear to contain the same colouring material, which the natives call *tinta punzo*—deep scarlet. The preparation and application of this colouring matter is a secret in the hands of certain families in the interior, who refuse to give to the public any information on the subject. The *lapacho* belongs to the family of the Bignonaceæ, and it is one of the most elegant representatives of the subtropical vegetation of the Northern Argentine Provinces. Several species of the *lapacho* are said to exist. The one most common, in the spring of the year, before the new leaves begin to sprout, is so densely covered with flowers that no ray of the sun can penetrate. The wood of this tree is remarkably firm and strong, and for that reason is in very considerable demand. In a chemical point of view the wood of the *lapacho* has also very remarkable qualities; of all the Argentine woods it produces the smallest amount of ashes, which are composed of the salts of phosphoric acid. In the second place, the chemical composition of its organic matter is very complicated. From experiments that have thus far been made it appears that its bark and wood afford about 7 per cent. of tannin, and 7·5 per cent. of colouring matter, which crystallises well, and about 12·5 per cent. of another colouring matter of less value, since it does not crystallise; also about 5 per cent. of a substance similar to caoutchouc. The latter is insoluble in water, and the wood long resists decay. It is stated, in fact, that when the wood has remained some time in water, it becomes indurated to such an extent that it is impossible to cut it even with an axe. The following is the method of preparing it for use as a dye wood:—A quantity of the sawdust or the shavings is boiled in iron vessels, and ten grains of crystallised carbonate of soda are added for each kilogramme of wood. After boiling for an hour, it is heated two or three times afresh with fresh quantities of water in other vessels. To the liquid extract which results from the portion of the wood already treated, the same quantity of wood and a proportionate quantity of carbonate of soda are added without interrupting the boiling of the liquid. The first portion of the wood already treated is then thrown into the second vessel which contains the same quantity of water, and to which for each kilogramme of wood five grains of carbonate of soda have been added. After an hour of this treatment the wood of the second vessel is passed to the third vessel, which should also contain pure cold water, and that of the first to the second, and so on. If in the first vessel five kilogrammes of wood to ten kilogrammes of water have been treated, the concentrated extract is thrown into another vessel to cool and to deposit its impurities. Then the liquid of the second vessel is passed to the first one, where it serves to treat fresh portions of the wood, that of the third to the second, and that of the fourth to the third. The wood which was in the fourth vessel is now found to be entirely deprived of its colouring matter. Finally, the water which served to boil the shavings in the first two vessels is added to the cold extract, which is precipitated by crude hydrochloric acid until the liquid colours litmus paper red. A yellowish green substance is precipitated in the crude colouring matter. After filtering it and washing in rain water, it is purified according to the following method:—It is dissolved with an equal weight of crystallised carbonate of soda in ten parts of boiling water—the filtered liquid is again precipitated when cold by hydrochloric acid, and the precipitate is washed until the water in which it is so heated does not present any acid reaction. Finally the dried mass is dissolved in boiling alcohol, and after filtering the alcoholic liquid, to separate the last impurities, it is crystallised. By following this method, ten kilogrammes of raw material and seven kilogrammes and a half of pure crystallised matter will be obtained from one hundred kilogrammes of wood, which is soluble in 7·75 parts of boiling alcohol and 85° or in 94·5 parts of cold alcohol. Inasmuch as this colouring matter, hitherto unknown, easily eliminates the carbonic acid of the carbonate of soda, and dissolves into a liquid the colour of blood, it is certain that it represents an organic acid. It is

for this reason, and in accordance with its origin, that it has been named lapachic acid. This acid, when crystallised by ether, forms very delicate little leaves of greenish yellow colour; when crystallised by alcohol the leaves and prismatic crystals are very small, and when crystallised by sublimation, it forms into the finest needles. Consul Baker says that the lapachic acid, its salts, and the products of its decomposition, merit much attention from dyers, because, according to the mordants and the degree of concentration of the flux, they produce very diverse colours in wool and silk; that is to say, whether the articles impregnated by the mordants be at once passed through the flux of the colouring matter or the contrary, or whether they are dyed in cold or heat, the following colours are produced—rose crimson, yellow, clear brown, and dark brown. It appears that nothing has yet been done in the matter of making the dyes and dye stuffs of the Argentine Republic articles of foreign commerce, and Consul Baker says that in spite of the fact that all parts of the country are so rich in these materials there has scarcely been a movement towards their utilisation beyond the meagre demands of a few spindles and hand-looms in the interior provinces, the people importing all the thread yarns and woven goods used in the country. He also adds that there is certainly a field here for the building up of a large trade in colouriug materials, and unless foreign enterprise comes in and takes advantage of the openings which the Argentine Republic offers in the several industries for the production of dyeing materials, they will remain undeveloped for as many centuries in the future as they have in the past. In regard to most of the dye woods and plants, they are found, or grow spontaneously in the country, and are immediately accessible along the shores of the Upper Paraná and the Paraguay. The *lepacho*, *quebracho*, and the *algorrobo* grow in great quantities and wonderful luxuriance all along these rivers.

General Notes.

Rendering Fabrics, &c., Incombustible.—Mr. W. K. Gilbert has sent the Secretary some particulars of the composition referred to by him in the discussion at Mr. Walter Emden's paper on the "Construction of Theatres." This composition is intended for rendering fabrics, paper, wood, &c., uninflammable. It consists of a combination of glycerine with certain salts, amongst which may be employed tartrate and phosphate of soda, the sulphate and carbonate of ammonia, or other phosphates, borates, tungstates, &c. The composition is applied in various manners, according to the material to be protected. Muslin and other fabrics may be dipped in it, and paper may be treated in the same way. In the case of timber, the composition is painted on with a brush. Mr. Gilbert states that the material has been adopted in certain of the Paris theatres for the treatment of scenery, dresses, &c.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 29. — Discussion on Mr. Swire Smith's paper, "The Technical Education Bill."

March 7.—"Framework Knitting." By W. T. Rowlett.

March 14.—"Technical Instruction in Agriculture." Prof. John Wrightson.

March 21.—"The Evils of Canal Irrigation in India, and their Prevention." By T. H. Thornton, C.S.I., D.C.L. Colonel Sir Owen T. Burne, K.C.S.I., C.I.E., will preside.

Dates to be hereafter announced:—

"Machine Tools for Boot and Shoe Manufacture." By John W. Urquhart.

"Locks and Safes." By Samuel Chatwood.

"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S.

"The Measurement of Electrical Currents." By Prof. George Forbes, F.R.S.

"Electric Lighting from Central Stations." By R. E. Crompton.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

March 20.—"The Decorative use of Colour." By J. D. Crace. E. C. Robins, F.S.A., will preside.

April 24.—"Craftsman and Manufacturer." By Lewis Foreman Day.

May 8.—"What style of Architecture should we follow?" By William Simpson.

May 29.—"Persian Textiles." By Cecil Smith.

Foreign and Colonial Section.

Tuesday evenings, at 8 o'clock:—

March 6.—"South African Gold Fields." By W. H. Penning, F.G.S.

March 27.—"The Panama Canal." By J. Stephen Jeans.

April 17.—

May 15.—"Emigration." By James Rankin, M.P.

Indian Section.

Friday evenings, at Eight o'clock:—

March 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. Mouat, M.D. Sir W. W. Hunter, K.C.S.I., LL.D., will preside.

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras. SIR JAMES CAIRD, K.C.B., will preside.

MAY 4.—"Caste." By Dr. G. W. Leitner.

The above dates are liable to alteration.

CANTOR LECTURES.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. John Mayall, Jun., "The Modern Microscope."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Robert Gordon, "The District of the Ruby Mines of Burma."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. H. R. Haweis, "Music, Emotion, and Thought."

TUESDAY, FEB. 28...Metropolitan Association for Befriending Young Servants (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture VII.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. R. A. Hadfield, (1.) "Manganese in its Application to Metallurgy;" (2.) "Some Novel Properties of Iron and Manganese."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Basil Hall Chamberlain, "Notes on the Japanese 'go-hei,' or Paper Offerings to the Shinto Gods" (with illustrative specimens). 2. Mr. Henry Balfour, "Exhibition of Decorated Arrows from the Solomon Islands." 3. Mr. A. W. Howitt, "Further Notes on the Australian Class Systems."

WEDNESDAY, FEB. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on Mr. Swire Smith's paper, "The Technical Education Bill."

Geological, Burlington-house, W., 8 p.m. 1. Mr. T. Mellard Reade, "An Estimate of Post-Glacial Time." 2. Prof. T. G. Bonney's paper by Mr. Charles Davison, "Note on the Movement of Scree-Material." 3. Mr. Grenville A. J. Cole, "Some Additional Occurrences of Tachylyte." 4. Mr. H. J. Carter, "Appendix to Mr. A. T. Metcalf's paper, 'Further Discoveries of Vertebrate Remains in the Triassic Strata of the South Coast between Budleigh Salterton and Sidmouth.'"

East India Association, Exeter-hall, Strand, W.C., 3 p.m. Mr. Seva Ram, "The Loyal and Patriotic Ideal of the Indian People."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. C. Street, "Our National Defences."

THURSDAY, MARCH 1...National Smoke Abatement Institution (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. E. J. Baker, "A New Genus of *Cytinaceæ* from Madagascar." 2. Mr. J. F. Cheeseman, "Notes on the Flora and Fauna of the Kermadec Islands."

Chemical, Burlington-house, W., 8 p.m. Dr. H. E. Armstrong, "The Origin of Colour and the Constitution of Colouring Matter generally."

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. Edward Freshfield, "Glimpses to the Parochial History of the City of London, as gathered from the Records." (Lecture I.)

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Dr. G. Sims Woodhead, "Milk and Disease."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert Parry, "Early Secular Choral Music." With illustrations. (Lecture IV.)

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, MARCH 2...United Service Inst., Whitehall-yard, 3 p.m. General J. J. H. Gordon, "The Native Army of Bengal; its Constitution, Organisation, Equipment, and Interior Economy."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. C. M. Tidy, "Poisons and Poisoning."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Mr. F. T. Elworthy, "Omissions, Redundancies, and Developments in Western English Dialects."

SATURDAY, MARCH 3...National Indian Association, Willis's Rooms, St. James's, S.W., 4 p.m. Sir W. W. Hunter, "Recent Movements in India."

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture VII.)

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FRIDAY, MARCH 2, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1888.

The attention of secretaries of examination committees is drawn to the fact that the Society's Examinations, with the exception of that for Practical Music, will be held on the evenings of Monday, 9th April, Tuesday, 10th April, Wednesday, 11th April, and Thursday, 12th April. Committees having candidates for examination must apply immediately to the Secretary of the Society of Arts for a form whereon to make their application for examination papers. These forms must be returned not later than the 12th instant. Candidates desirous of being examined should apply to the secretary of any Institution in union with the Society, or to the Secretary of one of the Examination Committees. Programmes of the Examinations, with lists of the Committees, can be obtained on application to the Secretary of the Society of Arts, John-street, Adelphi.

CANTOR LECTURES.

The first lecture of the course on "Modern Microscope," was delivered by Mr. John Mayall, jun., on Monday evening, 27th February. The lecture was illustrated by a large collection of microscopes, and by a series of lantern slides.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

INDIAN SECTION.

Friday, February 24, 1888; The Earl of Northbrook, K.C.S.I,, in the chair.

The paper read was—

THE RELIGIONS OF INDIA.

By Sir William Wilson Hunter, LL.D., K.C.S.I.

I lately read in a newspaper that the average cost of educating each student in a certain college at Oxford is £6,481. The calculation was, from an arithmetical point of view, unassailable. The revenues of the college were correctly given, and when divided by the number of so-called students they showed this enormous expenditure. The ingenious statist had, however, overlooked the fact that the income of that college is not applied to educating students itself, but to strengthening the teaching staff of the other colleges, or of the University, and to the endowment of research. No one, so far as I am aware, took the trouble to expose the miscalculation, and it passed as an amusing example of the abuse of figures.

There is a miscalculation, similar in kind, but fraught with more serious consequences —sometimes heard on English platforms, and reiterated in the Press—which saddens the hearts of thousands of earnest men and women in this country, and which carries discouragement to hundreds of devoted workers in distant lands. When I hear the result of Indian missions estimated by dividing their expenditure among the number of their conversions, and then giving the cost of each new convert at so much a head, the same effect is produced on my mind as by the statement regarding the average expenditure on each of the so-called students at that Oxford college. There may be initial periods of missionary effort among the Polynesian and African races to which a calculation of this sort can be properly applied. On that point I do not presume to offer an opinion. But speaking of the country in regard to which my own experience enables me to speak—the country which in our times forms the great field of missionary labour—I declare that no true ratio exists between

missionary expenditure or missionary work in India and the number of new conversions. I affirm that calculations based on the assumption of such a ratio are fundamentally unsound. It has been my duty to inquire into the progress of the various religions of India. The inquiry discloses a rapid proportionate increase among the native Christians unknown among the Muhammadan and Hindu population. But it also proves that the increase bears no direct relation to the new conversions from orthodox Hinduism and Islam.

For this misapplication of statistics the friends of missionary enterprise were originally, in some sense, responsible. The great outburst of evangelistic effort in India took place during the upheaval of Dissent against lukewarm orthodoxy in England. The first idea of our missionaries was to make converts from the established religions of India, as some of our Dissenting bodies at home hoped to swell their numbers at the expense of the Established Churches of Great Britain. During the past fifty years this idea has been modified. Experience has shown that a vast increase of activity and usefulness among the English and Scottish sects outside the Established Churches is not only consistent with, but has actually proved concurrent with, a vast increase of activity and usefulness within those churches. It has also shown that the progress of Christianity in India is compatible with the progress of Hinduism and Islam. For as the Dissenting bodies of Great Britain have in our century won their great successes not by a large absorption of good churchmen, but by their noble labours among the encompassing masses on the outskirts of religious life, so the missionaries in India have chiefly made their converts, not from the well-instructed Muhammadans and Hindus, but among the more backward races, and from the lower castes, who are destitute of a high faith of their own. There have been many conspicuous exceptions to this rule. But the rule has been so general, and the possibility of common progress is so evident, that a violently aggressive attitude towards the native religions is felt to be unsuitable in India, very much as the old *odium theologicum* between the Established Church and Dissent is felt to be an anachronism in England. In both countries it is the poor that have had the Gospel preached to them. In both countries the leaders of Christian thought have read again the opening words of the first missionary sermon, and recognised that "in every nation he that feareth God and worketh righteousness is accepted with Him."

In India especially, a religion must be judged not by its alarms and incursions into other encampments, but by the practical work which it does for its own people. For in India religious organisation plays a part in the social structure which it has long ceased to discharge among the more consolidated nationalities of Europe. The religious bond has to do in India for a dense population—subject to the overwhelming calamities of the tropics, and destitute of any Poor-law—what a highly developed system of State relief does for England. It has also to take the place of the innumerable charitable organisations which in England supplement and humanise State relief. The religious bond in India has to exercise the constraining moral influences on a multitude of self-contained communities which the cumulative force of public opinion exerts in more homogeneous nations. The religious force had, until our own days, to supply the motive power of Indian education; nor are signs wanting that it will again assert itself actively in the spread of Indian schools. The religious bond in India forms an important factor in mercantile credit, and tends to concentrate trade within certain communities of joint believers. To sum up, religious organisation in India does the work of public opinion and of a Poor-law; it forms the basis of private benevolence and of mercantile credit; it supplied until lately the motive power of public instruction. In such a country, I repeat, a religion must stand or fall by what it does for the well-being of its own people.

I propose to apply this principle to three great religions of modern India—Muhammadanism, Hinduism, and Christianity. British rule has created a new world in India, with new problems of existence which each community must solve for itself. What power do the various religions disclose of adapting themselves to this new world, what solutions do they offer for its new problems? I am well aware that any theological discussion, or even any expression of my own belief, would be out of place within these walls. But while, in addressing this Society, I confine myself to the social results of Christianity in India, I by no means wish to urge my present point of view to the exclusion of its more spiritual aspects.

There is a dense and dark mass of fifty millions of human beings in India lying on the outskirts or beyond the pale of orthodox Hinduism

and Islam. I believe that, within fifty years, these fifty millions will be absorbed into one or other of the higher faiths, and that it rests in no small measure with Christian England whether they are chiefly incorporated into the native religions or into Christianity. But a cordial recognition of the wide field for evangelical labours does not exempt Christianity in India from being judged by its present results. Nor need the friends of missionary enterprise shrink from the test. For while the number of native Protestant Christians has increased by five-fold during the thirty years preceding the last census, the number of their communicants has multiplied by nearly ten-fold. The progress has been a progress of conversion concurrent with a progress of internal growth and of internal discipline. It is the result not alone of the zeal which compasseth the earth to make a proselyte but also of the pastoral devotion which visits the fatherless and widows in their affliction, and labours to keep its flock unspotted from the world.

In considering the practical aspects of the three religions, it is convenient to begin with the Muhammadans. Islam represents in British India a compact and coherent mass of forty-five millions, who, in spite of internal divisions, are more closely united than any equally large section of the people by a common religious bond. For this vast aggregate a rate of progress has been claimed in a recent discussion in the *Times* which, if well founded, would have an important political and social significance. We may miss the fine courtesy of St. Paul in the controversy of the Canons, but their appeal to statistics was substantially a just appeal. Any general inferences, however, deduced for the whole of India from the last census are fallacious. For the great Muhammadan provinces lay outside the influence of the famine of 1877. That calamity fell with its full force on the essentially Hindu Presidency of Madras, and on the Hindu districts of Bombay. The British Provinces of the Indian continent beyond the famine area of 1877 were seven in number: the Lieutenant-Governorship of Bengal, which contains nearly one-half of the whole Muhammadans of British India, Assam, the North-Western Provinces, Sind, the Central Provinces, the Punjab, and Oudh. In the first five of these a census was taken in 1872, and another census in 1881, and we can compare the results of those enumerations. In the last two, viz., the Punjab and Oudh, no census was taken in 1872, and the census officers of 1881 declared that in these two provinces data did not exist for testing the progress of the religious divisions of the people.* Taking the same area of enumeration, and avoiding the pitfalls into which persons unfamiliar with the Indian census are apt to stumble, the facts in the five Indian provinces outside the famine of 1877, and for which we possess comparative data—are as follow:—

Proportionate Progress of Muhammadans to General Population, from 1872 *to* 1881.

	Increase of General Population. Per cent.	Increase of Muhammadans. Per cent.
Lieut.-Governorship of Bengal†	10·89	10·96
Lieut.-Governorship of the North-Western Provinces‡ (without Oudh)	6·30	7·16
Sind	9·56	9·93
Assam§	19·23	19·17
Central Provinces‖	25·21	18·55

The slight differences (where they exist) may be accounted for by local circumstances. Thus, in the North-Western Provinces, the Musulmans live more in the cities than the Hindus, and they are less influenced by the intense pressure of the population on the soil, which keeps down the increase among the rural inhabitants. In Bengal, the Muhammadans chiefly occupy the eastern districts, in which there still is plenty of spare land, and consequently a high normal increase of the population. The census officer for Bengal states that no conversions to Islam on a considerable scale can have taken place since 1872.¶ The census officer for the North-Western Provinces reports in the same sense, but in greater detail.

"I have consulted experienced and observant district officers throughout the province," he writes,** "and they all agree that there is no active propaganda of Islam to be met.

* See "Report on the Punjab Census," vol. i., p. 108 and 109 (Paras. 208, 210), Lahore, 1883; and "Report on the Census of the North-Western Provinces and Oudh," p. 61 (Para. 83) Allahabad, 1882. In Oudh, for example, the schedule for the last rough enumeration in 1869, contained no column for the entry of religion.

† "Bengal Census for 1881," vol. i., p. 79, paragraph 191. In this paragraph of the Bengal Census Report, there is a misprint of 28,704,724, for 21,704,724.

‡ "North-Western Provinces Census for 1881," vol. i., p. 20, and p. 60.

§ "Assam Census Report" for 1881, page 35, paragraph 65.

‖ "Central Provinces Census Report" for 1881, pages 12 and 47.

¶ "Bengal Census for 1881," p. 79, paragraph 191.

** "North-Western Provinces Census Report for 1881," vol. i., p. 62.

There are, however, many motives, apart from conscientious religious conviction, which induce Hindus to embrace the faith of Islam. Mr. T. Stoker, C.S., in a note furnished to me on the subject, writes :—'In this part of India there has been no such thing as a religious conversion from the Hindu to the Musalman faith. Even a solitary case might be sought for in vain of such a change of religious belief from conscientious conviction. But a certain, though small, amount of conversion is going steadily on. It proceeds from social and economical reasons, and is confined to the lower orders, and, I should judge, occurs oftener among females than males. Hindus who have, for one reason or another, lost caste; women who have fallen into an immoral life; men who have abandoned their family faith for the sake of a woman of the other creed—these, and such as these, release themselves from the restraints and inconveniences of caste rules by adopting Islam. In such conversions religious feeling has no place. Years of famine are fruitful in such changes. Children or women, whose parents or relatives died or deserted them—persons of all ages, and both sexes, who were forced by distress into acts which destroyed their status —go over to a religion that receives all without distinction.'"

But while the statistics do not indicate any extraordinary increase of the Indian Muhammadans during recent years, they speak in eloquent language of the progress made by Muhammadanism in the past. The popular idea of Islam in India is that of a conquering creed, which set up powerful dynasties, who in their turn converted, more or less by force, the races under their sway. This theory is refuted by the facts. Excluding the frontier province of the Punjab—which, but for the religious revival represented by the Sikh confederacy, ought, in the course of historical events, to have become almost as exclusively Muhammadan as Afghanistan—the part of Northern India which is most strongly Muhammadan is the part most remote from the great centres of Muhammadan rule. In the British Lieutenant-Governorship of the North-Western Provinces and Oudh—which at one period or another of its constitution contained the three Muhammadan capitals of Delhi, Agra, and Lucknow, and in which the Muhammadans were pre-eminently the dominant caste—the proportion of Muhammadans to the general population is under 13½ per cent. In the British Lieutenant-Governorship of Lower Bengal, far remote from the three Muhammadan capitals, the proportion in 1881 was 31 per cent. But the facts come out more clearly if we compare the districts immediately around the ancient Muhammadan capitals with districts on the outskirts of the Muhammadan empire. In Delhi district, including the metropolis of the Mughals, the Muhammadans do not form a fourth of the population; in Agra district, including the Muhammadan capital of Agra, they barely exceed one-tenth. But in Rajshahi district, bordering on the remote Gangetic Delta, the Muhammadans exceed three-fourths of the whole population; and in Maimansinh district, on the furthest limits of Lower Benga they amount to two-thirds. Indeed, throughout the seven most eastern and most distant districts of Lower Bengal, the Muhammadans form close on 8,000,000 of the 12,000,000 inhabitants, or practically two-thirds of the whole population.

The explanation is, that in Northern India Islam found itself hemmed in by strongly organised forms of Hinduism of a high type, on which it could make but slight impression. Indeed, Hinduism here reacted so powerfully on Islam that the greatest of the Mughal sovereigns, Akbar, formally renounced the creed of the Prophet, and promulgated a new religion for the empire, constructed out of the rival faiths. But the Muhammadan adventurers and missionaries who penetrated into the swamps and jungles of Lower Bengal found there a population of low-castes, very different from the compact Hindu communities of Northern India. To these poor people, fishermen, hunters, pirates, and low-caste tillers of the soil, whom Hinduism had barely admitted within its pale, Islam came as a revelation from on high. It was the creed of the governing race; its missionaries were men of zeal who brought the gospel of the unity of God and the equality of man in his sight to a despised and neglected population. The initiatory rite rendered relapse impossible, and made the proselyte and his posterity true believers for ever. In this way Islam settled down on the richest alluvial province of India, the province which was capable of supporting the most rapid and densest increase of population. Compulsory conversions are occasionally recorded. But it was not to force that Islam owed its permanent success in Lower Bengal. It appealed to the people, and it derived the great mass of its converts from the poor. It brought in a higher conception of God, and a nobler ideal of the brotherhood

of man. It offered to the teeming low-castes of Eastern Bengal, who had sat for ages abject on the outermost pale of the Hindu community, a free entrance into a new social organisation. It succeeded because it deserved to succeed.

The proselytes carried, however, their old superstitions into their new faith. Their ancient terror of the Unseen Malignant Powers reasserted itself with an intensity that could not be suppressed, until the white light of Semitic monotheism almost flickered out amid the fuliginous rites of low-caste Hinduism. In the cities, or amid the serene palace life of the Musalman nobles and their religious foundations, maulvis of piety and learning calmly carried on the routine of their faith. But the Muhammadan masses in large parts of Lower Bengal relapsed into something little better than a mongrel breed of circumcised Hindus, few of whom could repeat the simplest formula of Islam.

During the present century, one of those religious revivals so characteristic of India has swept across the Muhammadans of Lower Bengal. Itinerant preachers passed from district to district, calling on the people to return to the true faith, and denouncing God's wrath on the indifferent. The Bengal Musalmans have, to a large extent, purged themselves of low-caste superstitions and rural rites. This re-awakening of the old Puritan spirit of Islam has widened the gulf between the Bengali Musalmans and the Hindus. It has also increased the difficulty which the Bengal Muhammadans find in accepting the system of religious toleration imposed by British rule.

Apart from temporary disturbing influences, such as the political preaching of Wahabi missionaries, the answer which Islam gives to the modern problems of India differs widely in different provinces. In the North-Western Provinces and Oudh, where the Muhammadans were for centuries the dominant class, they have vigorously vindicated their position in the new world of British India. Finding that the only claim to administrative employment recognised by our Government is the individual's own fitness for the discharge of public duties, they have strenuously qualified themselves for official life. The proportion of Muhammadans in the schools and colleges under the Lieutenant-Governor of the North-Western Provinces and Oudh is in excess of their ratio to the general population. They show also an admirable nergy in independent educational efforts, and the great Muhammadan college at Aligarh, founded in our own days by the Musalman nobles and gentry, would do honour to any age or to any country of Islam. Competing successfully with the Hindus at school, the Muhammadans of the North-West and Oudh also compete successfully with them in life. While the Musalmans number under $13\frac{1}{2}$ per cent. of the population in that British Lieutenant-Governorship, they have won for themselves 34 per cent. of the administrative offices. In the superior grades they engross an even larger share. While forming not one-seventh of the population, they have won four-sevenths of the highest judicial and executive posts, open impartially to Muhammadans and Hindus. In Bombay, apart from Sind, the Muhammadans largely belong to the merchant classes. They take fair advantage of State education up to the standard required for their own work in life.

While the Muhammadans have thus asserted themselves as the old dominant race in the North-Western Provinces and Oudh, and as practical trading communities in Bombay, the Musalmans in Lower Bengal have fallen behind in the race. In 1871, when they formed 32 per cent. of the population of Lower Bengal, they only numbered 14 per cent. in the schools, and 4 per cent. in the colleges. Their inability to adapt themselves to our educational system told heavily against them in life. In 1871, only 92 gazetted appointments in Lower Bengal were held by Muhammadans, as against 681 held by Hindus. From the open professions they had almost disappeared. To take one example. At the beginning of the century nearly the whole of the pleaders of the Calcutta High Court were Muhammadans, and down to 1838 they numbered about as many as the English and the Hindu pleaders put together. But with the introduction of scholastic tests, based on our Indian system of education, the Muhammadans fell out of their hereditary profession, and of the 240 native pleaders admitted from 1852 to 1868, only one was a Musalman.

The poverty and discouragement which this state of things wrought among the Bengali Musalmans attracted the earnest consideration of the late Lord Mayo, and in 1871 measures were taken to render our system more congenial to the Muhammadans of Lower Bengal. The result has been to awaken a new vitality among them. Two powerful associations in Calcutta, with branches in the

Muhammadan districts, now stimulate and direct local effort. The number of Muhammadans at schools known to the Education Department in Lower Bengal has risen from 28,148 in 1871, to 261,887 in 1881. This great increase is chiefly due to the extended sphere of the Education Department itself. But the proportion of Muhammadans at schools in Lower Bengal also rose during the same period from 14 to 24 per cent., an increase of 70 per cent. in 10 years. In 1883, they obtained still further concessions from the Education Commission. The position of the Bengali Musalmans in the public service and in the open professions has also improved, although more slowly, for the effects of their new educational activity will bear its full fruits only when the rising generation have established themselves in life. It must also be remembered that the Bengali Musalmans are largely drawn from the peasant class, which does not naturally seek official employment.

Broadly speaking, therefore, while the old dominant Muhammadan races of the North-West and Oudh, and the keen merchant Muhammadan communities of Bombay, have vigorously accommodated themselves to the new world of British rule, the Muhammadan masses in Lower Bengal have disclosed a more tardy capacity of adaptation, although they have strong capabilities of adjustment, as proved by their progress since 1871.

Islam in India has shown that it is perfectly able to dwell in peace and comfort in the new Indian world; this, moreover, in spite of drawbacks arising from the too exclusively religious character of the Muhammadan primary schools. The one object of the young Hindu (apart from his home religious training) is to get such an education as will fit him for success in life. But with the young Musalman the teaching of the Mosque must precede the lessons of the school. Before he is allowed to begin his secular education he must ordinarily devote some years to a course of sacred rudiments. Again, while the ablest of the Hindus look forward to the public services, or the lucrative professions, a Muhammadan father often chooses for his most promising son the vocation of a religious man of learning. The years which the Hindu student gives to English and mathematics at a Government college, the Muhammadan devotes in a madrasa, to Arabic, and the law and theology of Islam. These differences, in regard both to primary and to higher education, heavily weight the Muhammadans in the race of official or professional life. But the sternly religious character of their early teaching gives a vigorous coherence to Islam in India which may yet be productive of great political results.

I have spoken at some length of the Musalmans, because, notwithstanding provincial differences, it is possible to deal with Indian Muhammadanism as a whole. But Hinduism is so vast, and so various, that it is not practicable to treat it comprehensively without overstepping the limit of time allowed me. I shall, therefore, briefly state the main results at which I have arrived, and I respectfully refer those who desire to test my conclusions, to the more complete analysis of Hinduism in my "Indian Empire."

Hinduism is a social organisation, and a religious confederacy. As a social organisation it rests on caste, with its roots deep down in the tribal elements of the Indian people. As a religious confederacy, it represents the coalition of the cultured faith of the Brahmans with the ruder rites and materialistic beliefs of the more backward races.

In both aspects Hinduism is a deliberate system of compromise. For the highest minds it has a monotheism as pure as, and more philosophical than, the monotheism of Islam. To less elevated thinkers it presents the triune conception of the deity as the Creator, the Preserver, and the Destroyer—with the deeper doctrine superadded that destruction and reproduction are fundamentally one and the same process. To the materialistic multitude it offers the infinite phases of divine power as objects of adoration, with calm indifference as to whether they are worshipped as symbols of the unseen Godhead or as bits of tinsel and blocks of wood and stone. It resolutely accepts the position that the spiritual needs of races differ in each stage of their development, and that man most naturally worships what, for the time being, he most reverences or most fears. On this foundation, Hinduism has built up the enduring but ever-changing structure of Indian ritual and belief.

As a social organisation, Hinduism is even more fundamentally based upon compromise. It declares, under solemn sanctions, the immutable ordinance of caste; and it asserts, in lofty language, the unapproachable God-given supremacy of the Brahmans. But it skilfully adapts these doctrines to the actual facts. It finds in India a vast number of communities,

more or less isolated by geographical position, by occupation, or by race. It accepts the customs and internal life of each of these communities as the proper and normal status of that individual community or caste. But it holds out to all an ascending scale to a higher life—the life of ceremonial purity, of self-discipline, and of religious restraint, which is the ideal life of the Brahman. If any community or caste is to rise in the social scale, it must be by an increase of ceremonial purity. Accordingly, when any caste becomes rich or influential, its first ambition is to draw tighter its internal discipline and its religious restraints. By this process many castes have risen, such as the Vaisyas of the north and west, the Shahas, Telis, and Tambulis of Eastern Bengal, the goldsmiths of Madras, and the semi-aboriginal warrior tribes, or so-called Rajputs, in numerous parts of India. In some cases they have abandoned their laborious low-caste occupations for higher employments. In others they have assumed the sacred thread of the Twice-born. But in addition to such individual examples, the constant presentment of a higher caste-life tends to a general upward movement in religious restraints as the wealth of the population increases. The backward races outside the pale of Hinduism set up a Hindu priest and a Hindu god, and become recognised as low-caste Hindus. The more energetic or more fortunate of the low-castes, within the Hindu pale, gradually raise themselves to higher standards of ceremonial purity.

There is therefore a plasticity as well as a rigidity in caste. Its plasticity has enabled Hinduism to adapt itself to widely diverse stages of social progress, and to incorporate the various races which make up the Indian people. Its rigidity has given permanence to the composite body thus formed. Each caste is in some measure a trade guild, a mutual insurance society, and a religious sect. But the mass of them are dominated by two ideas—a communal life within the caste itself, and a higher life of ceremonial purity beyond. The work of Hinduism has been to organise the Indian races, in every stage of their progress, and under many forms of political government. Its plastic conservatism quickly disclosed a capacity of adapting itself to British rule.

For a time, indeed, there seemed to be a difficulty. Hinduism makes a social rise dependent upon an increase in ceremonial purity. In the new world of British India, social advancement depends upon individual exertion, and secular success. The Hindu system told in favour of ceremonial restraints, the English system told against them. But English education, which created the difficulty, also found an escape from it. For Brahman theology declares that later customs, or later doctrines, are less binding than the older sacred books, and has always allowed an appeal back from the Puranas of mediæval Hinduism to the ancient Veda. This appeal has been boldly made by the educated Hindus under British rule, and it is found that the most irksome ceremonial restraints of modern Hinduism derive no support from that venerable scripture. Even the orthodox educated Brahmans now perceive that those restraints rest upon mediæval custom, and not upon Vedic inspiration; and they are gradually admitting that custom, although not lightly to be changed, must, in the end, adjust itself to the conditions of modern life. In regard to widow-burning, to infant marriage, to widow re-marriage, to crossing the Black Water, and to various inhumane rites—the appeal to the Veda has been successfully made. In some cases the custom has been given up, in others it is seen to depend on religious or domestic usages, which, however binding, are yet susceptible of change.

Hinduism has solved the social problems of the new Indian world, or is gradually finding solutions for them. It has frankly accepted English education, and the modern methods of success in life. And when once Hinduism fairly incorporates a new idea, the new idea becomes an enduring part of its own ancient structure. Meanwhile, for the few who pass from its higher castes to Christianity, many rise in the scale of ceremonial purity within the Hindu body, and multitudes of the backward races enter its pale. Hinduism not only grows within itself, but it has also the faculty of putting forth outgrowths in the form of new religious orders, or spiritual brotherhoods. Such religious orders usually recall the Buddhistic type. They start with the reassertion of the unity of God, and with the substitution of a monastic fraternity for caste. At first they are considered non-orthodox, but in time they become recognised Hindu sects. Some of them, such as the great Vaishnava orders, now form a considerable part of the Hindu population. Hinduism has, therefore, a two-fold power of adapting itself to the needs of each age; by an internal process of incorporation or adjustment on the basis of caste; and by an external process of throwing off new religious outgrowths, or spiritual brotherhoods.

Into the midst of this ancient and powerful organisation, a new religious force has in our century thrust itself, a force animated by a profoundly different spirit. Christianity is not, indeed, a new religion in India. Its history in that country dates from a period seven hundred years before the rise of mediæval Hinduism, and a full thousand years before any widespread Indian settlement of Islam. It has been my privilege to relate, from local materials, that marvellous narrative. I have shown how the Christian settlements on the Indian coast of the second and subsequent centuries came, after a time of decay, under Nestorian bishops from the Persian Gulf. How the Nestorian Christians of India were persecuted by the Portuguese, and trampled down by the Synod of Diamper in 1599, their venerable missals and church ornaments burned, and their consecrated oil poured out upon the flames. How, on the decline of the Portuguese power, their desolate remnants obtained a new bishop from Antioch, but of the Jacobite branch of the Asiatic Church, and how they have since adhered to the Jacobite rite. How, meanwhile, the Catholic Church had entered the field with a splendour of devotion and success which makes us the more deeply lament her intolerance to the earlier form of Indian Christianity. How the great religious orders of Rome, with the Society of Jesus at theit head, built up a true native church in India by three centuries of unflagging labour and wisely directed zeal, before the heart of England was stirred by the missionary impulse. How, during the last of those centuries, while the English conscience still remained inert, the Lutheran Church of Europe sent men of power to India. And how, at length, England slowly, but surely, saw her duty, and the churches of the great English speaking race, by whatever name they may be called, and in whatever land they dwell, girded themselves for a mighty and enduring effort.

Although, however, Christianity has a history in India long before the rise of mediæval Hinduism or Islam, yet the historical Christianity of India differed widely from the missionary Christianity of our day. When the Portuguese landed in India, they found the Christians firmly organised as military communities under their spiritual leaders, bishops or archdeacons and priests, who acted as their representatives in dealing with the Indian Princes. In virtue of an ancient charter, the Malabar Christians enjoyed the rights of nobility. They supplied the bodyguards of the local kings. The Portuguese, by a happy chance, landed on the very province of India in which Christians had long formed a respected caste. *O fortunati nimium, sua si bona norint.* But instead of consolidating the pre-existing Christian communities, they ground them to pieces under the mill-stone of the Inquisition, and built up a showy evanescent rule out of entirely new materials. While, however, the Nestorian Christianity of India was thus of a bygone type, the records of Catholic Christianity are pregnant of instruction for our day. The great question with the Jesuit missionaries, as with our own, was how to adapt the Christianity of Europe to the Indian races without sacrificing essentials of the faith.

But the new religious force now at work amid Hinduism is neither the Nestorianism of the patriarchs nor the Catholicism of the popes. The Catholic and Syrian churches still go on calmly with their great task, and claim over 1,600,000 of the 2,148,228 Christians in India. The new disruptive force is Protestant and Anglican Christianity.

English missionary work practically began in the last year of the last century. It owed its origin to private effort. But the three devoted men who planted this mighty English growth had to labour under the shelter of a foreign flag, and the governor of a little Danish settlement had to refuse their surrender to a Governor-General of British India. The record of the work done by the Serampur missionaries reads like an eastern romance. They created a prose vernacular literature for Bengal; they established the modern method of popular education; they founded the present Protestant Indian church. They gave the first great impulse to the Native Press. They set up the first steam-engine in India; with its help they introduced the modern manufacture of paper on a large scale; in ten years they translated and printed the Bible, or parts thereof, in 31 languages. Although they received help from their Baptist friends in England, yet the main part of their funds they earned by their own heads and hands. They built a college which still ranks among the most splendid educational edifices in India. As one contemplates its magnificent pillared façade overlooking the broad Hugli river, or mounts its costly staircase of cut brass (the gift of the King of Denmark), one is lost in admiration at the faith of three poor men who dared to build on so noble a scale.

From their central seminary, they planted

out their converts into the districts, building churches and supporting pastors chiefly from the profits of their boarding-school, their paper-mill, and printing-press. They blessed God that, during their 38 years of toil, they were able to spend more than £50,000 of their own substance on His work. But when two of them had died, and the third was old and broken, the enterprise proved too vast for individual effort; and the Serampur Mission was transferred to stronger hands. In death they were not divided. An evergreen circle of bamboos and palms, with delicate feathery masses of the foliage of tamarind-trees, surrounds their resting-place. A path, lined with flowering shrubs, connects their tombs. And if the memory of a great work and of noble souls can hallow any spot, then this earth contains no truer *campo sancto* than that Serampur graveyard.

To this dayspring of missionary labour by private enterprise succeeded a period of organised effort. The Charter of 1813, which threw open India to the free commerce of England, also recognised the religious responsibilities of England in the East, and sent out the first English Bishop of Calcutta. The London Missionary Society and the Baptists had already commenced their labours in India. The Church Missionary Society, the Society for the Propagation of the Gospel, the great Nonconformist and Presbyterian societies, quickly entered the field. Before 1830, nine missionary bodies were at work; in 1881, there were fifty-seven separate missions, with 601 stations, in India and Burmah. Their first task was to prepare the way, by popular instruction, for higher belief. Before the Indian Government awoke to the duty of public instruction, a great system of missionary education had been spread over the land. Since 1854, when the State at length fully realised its responsibilities, the missionary schools and colleges have not only retained their hold on the people, but their attendance has increased three-fold.

At one time, indeed, it seemed to earnest men as if this great task of Indian education threatened to engross too large a share of Indian missionary zeal. But during the past twenty years, the spiritual force which animates all missionary work has received a fresh impulse from a movement that recalls the early period of private missionary effort. It is the private effort, however, not alone of individual men but of small fraternities animated by a highly concentrated devotion. These little communities, such as the Cowley Brotherhood, the Oxford and the Cambridge brethren, bring to their work the highest culture of the West. But they also present that type of ascetic zeal and self-denial which in India, from the Great Renunciation of Buddha down to the latest movements of Hinduism or Islam, has always formed the popular ideal of the missionary life.

The statistical results achieved by these three missionary periods in India—the period of private effort, the period of great organised societies, and the period of societies side by side with ascetic brotherhoods—may be thus summarised. In 1851, the Protestant missions in India and Burma had 222 stations; in 1881, their stations had increased nearly three-fold to 601. But the number of their churches or congregations had, during the same thirty years, multiplied from 267 to 4,180, or over fifteen-fold. There is not only a vast increase in the number of the stations, but also a still greater increase in the work done by each station within itself. In the same way, while the number of native Protestant Christians increased from 91,092 in 1851, to 492,882 in 1881, or five-fold; the number of communicants increased from 14,661 to 138,254, or nearly ten-fold. The progress is again, therefore, not alone in numbers, but also in pastoral care and internal discipline. During the same thirty years, the pupils in mission schools multiplied by three-fold, from 64,043 to 196,360.

These enormous increments have been obtained by making a larger use of native agency. A native Protestant Church has, in truth, grown up in India, capable of supplying, in a large measure, its own staff. In 1851 there were only 21 ordained native ministers; by 1881 they had increased to 575, or twenty-sevenfold. The number of native lay preachers had risen during the thirty years from 493 to the vast total of 2,856.

The foregoing figures are compiled from returns carefully collected from every missionary station in India and Burmah. But the official census, notwithstanding its obscurities of classification and the disturbing effects of the famine of 1877, attests the rapid increase of the Christian population. So far as any inference for British India can be deduced, the normal rate of increase among the general population was about 8 per cent., while the actual rate of the Christian population was over 30 per cent. But taking the

Lieutenant-Governorship of Bengal as the greatest province outside the famine area of 1877, and for whose population, amounting to one-third of the whole of British India, really comparable statistics exist, the census results are clear. The general population increased in the nine years preceding 1881, at] the rate of 10·89 per cent., the Muhammadans at the rate of 10·96 per cent., the Hindus at some unknown rate below 13·64 per cent., the Christians of all races at the rate of 40·71 per cent., and the native Christians at the rate of 64·07 per cent.*

If, therefore, at the beginning of this paper, I protested against missionary work in India being judged by a mere increase in numbers, it was not because I feared the test. It was, I again repeat, because a religion in India must be judged by the work which it does for its own people.

On the spiritual results of conversion I may not here touch. But Christianity holds out advantages of social organisation not offered by Hinduism or Islam. It provides for the education and moral supervision of its people with a pastoral care which Islam, destitute of a regular priesthood, does not pretend to. It receives the new members into its body with a cordiality and a completeness to which Hinduism is a stranger. The backward races can only creep within the outskirts of Hinduism as low-castes at the very bottom of the social edifice; and Hinduism is calmly indifferent as to whether they enter its pale or not. Hinduism has no welcome for the proselyte. No change of faith can win for an outsider admission into a respected Hindu caste. Christianity also raises the position of woman to a degree unknown to Hinduism or Islam. To its converts in general, it assures friendly companionship, pastoral direction, and, when needful, some amount of material aid in their way through the world. Any youth of promise among its body is quickly selected for special instruction, and has an exceptional chance of advancement in life.

On the other hand, the native Christian is exposed to a terrible temptation. Islam is a great teetotal society. Among Hindus, to touch liquor is the sign of low caste. I do not agree with the old Colonel who writes in the newspapers that every Christian servant in India drinks. But it is very sad that the careless honest observer should so often arrive at this generalisation. I, for one, believe that if Christianity is to be an unmixed blessing in India, it must be Christianity on the basis of total abstinence. This self-imposed restriction would, in India, soon grow into a binding custom, and would raise the Christian communities out of the rank of the liquor-drinking castes. I further believe that Christianity in India must distinguish more clearly than heretofore between moral usages binding on the Christian societies of Europe and the essentials of its faith. For example, if a man has had two wives before conversion, it seems to me an inhumanity and an injustice that a change in his personal creed should annul his previous obligations. Such cases are not frequent. But they are generalised by the native critic somewhat as the drunkenness of the Christian servants is generalised by the old Colonel. In this, as in other matters, Indian Christianity must be more content to work with pre-existing materials, and on the basis of historical Indian institutions; to follow, not the example of the Portuguese to the Nestorian Christians, but the pattern of the early Church.

The Indian mission-station reproduces in its best form the most enduring territorial unit of Christian organisation. It is the true *paroikia* of primitive days, neither a parish nor a diocese, but the Christian community, whether in a city or a district, as differentiated from the surrounding non-Christian population. The early Church did not disdain to borrow the names of its offices, and the methods of appointing its officers, from the municipal and rural institutions of the Roman Empire. Its organisation closely followed the lines of the many friendly and religious societies into which men formed themselves for mutual help, amid the social strain and spreading poverty of that period. In India the religious bond has always been a social *nexus*. The historical institutions of India afford a basis for a great Christian community, as firmly united by internal discipline and mutual help as was the early Church. I believe it is reserved for Christianity to develop the highest uses of Indian caste, as a system of conservative socialism which has for ages done the work of a poor-law, of public opinion, and of a moral police. But it will be Indian caste humanised by a new spiritual life. The wonderful growth of the native clergy in recent years has done something to bring Christianity closer to native institutions. The appointment of native bishops, for which the time is manifestly at hand, will do more. Indian Christianity,

* "Bengal Census Report, 1881," vol. 1, pp. 41, 76 and 84 paras. 104, 182, and 203).

organised on the Indian communal basis, and in part directed by native spiritual leaders, would reproduce, as far as the divergent creeds of modern times permit, Tertullian's picture of the early churches united by "the communion of peace, the title of brotherhood, the token of hospitality, and the tradition of one faith." I earnestly trust that the fathers of the Pan-Anglican church, when they meet in synod next summer, may be led to consider Indian Christianity from this point of view.

Meanwhile Christian modes of thought are profoundly influencing Indian opinion in regard to the status of woman. It was by no accident that the widows and virgins appear so often as objects of solicitude to the early Church. Their well-being still forms a chief care of the Indian Mission station. For a time the Indian Christians seemed to have solved the difficulty of providing for their women very much as the Hindus solve it—by early marriage. Indeed, the Census Commissioner reported, in 1881, "That in the native Christian community early marriages prevail even to a greater extent than amongst the Hindus."* Such a state of things means a disregard of economic laws, which sooner or later must bring its punishment. The ablest missionaries perceive this, and are resolutely fitting the Christian women to earn their livelihood by other means than by marriage alone. For long the missionaries may be said to have made female education their own; and even since the Indian Government accepted this duty the number of girls in missionary schools has multiplied five-fold. The one profession in India which is not overcrowded is that of the schoolmistress; and if Christian native women can win the confidence of the non-Christian community, they will in time find well-paid employment. In this great task of raising the position of Christian womanhood in India, it is impossible to overrate the work done by the wives of missionaries, and by devoted ladies from England and America. The hall-table at which the three Serampur missionaries held their deliberations is kept sacred as when they sat round it. Two of their chairs stand at either side, the third chair at the foot. But at the head of the table is the chair of honour, in which Mrs. Marshman presided over their conferences—the first of many great-hearted Englishwomen who have consecrated their lives and their substance to India.

* "Indian Census Report, 1881," vol. i., page 90, para. 125.

I thank this Society and its distinguished Council for the opportunity they have given me of telling some plain secular truths concerning the religions of India. It is not permitted to a lecturer here to speak as the advocate of any creed. But on this, as on every platform in England, it is allowed to a man to speak as an Englishman. And speaking as an Englishman, I declare my conviction that English missionary enterprise is the highest modern expression of the world-wide national life of our race. I regard it as the spiritual complement of England's instinct for colonial expansion and imperial rule. And I believe that any falling off in England's missionary efforts will be a sure sign of swiftly coming national decay.

DISCUSSION.

Sir GEORGE CAMPBELL, K.C.S.I., M.P., said the subject was so vast that it was hardly possible, on the spur of the moment, to make any observations which would be useful to the meeting, and, therefore, he should confine himself to stating that he had been greatly pleased with what he might describe as an eloquent, thoughtful, and interesting paper. He entirely concurred with the first part of the paper as to the position which Muhamadanism occupied in India. As to the disappointing position occupied by the Muhammadans, this might be accounted for by the fact that they laboured under very peculiar circumstances, which, no doubt, had hindered them taking advantage of English education; but beyond that there was another thing, viz., that the great mass of Muhammadans of Bengal were cultivators of the soil, so that one could not expect from that class that a very large portion would attain the highest posts. He was afraid that Sir William Hunter had taken a somewhat too sanguine view with regard to the progress of Christainity in India, though he agreed that marvellous efforts had been made in the direction of education. He was afraid that what had been done in the direction of the spread of the Christian religion had resulted in more undermining Hinduism than setting up another religion. He hoped that Christian missionaries would place before the natives the original Christianity of Jesus Christ and not the dogmatic Christianity of modern days. He thought they might have done more than they had in the conversion of the great aboriginal races, by presenting a pure and Christian religion.

Dr. PRINGLE said it was not easy to criticise the paper, after the able manner in which the subject had been dealt with. No one could have lived in camp in the Muttra district, as he had done some years ago, without being struck with the remarkable

similarity between the story of Krishna and the story of the Christ, and doubtless some of the earliest accounts of the Gospel must have reached Muttra. On pointing this out to some natives, they told him of one place where the evil spirit killed the cows —because in India the story was told by the cow-herds—by driving them over the precipice into the Jumna below. Another remarkable similarity was the story of King Kauntze, whose order to kill the infant Krishna was the origin of the toy known as the Muttra Miracle, of which several were in the late Indian Exhibition. From these, and other accounts which he heard in India, he came to the conclusion that Christianity must have reached India at a much earlier date than was generally supposed. With regard to social caste, the effects were very marked between Hindus and Muhammadans, and distressingly so, when one had anything to do with a famine or prevalent sickness. The Hindus suffered terribly, while the Muhammadans suffered infinitely less. There was a sort of brotherhood among the Muhammadans which there was not among the Hindus. It was well known that small-pox inflicted terrible ravages in India, but yet comparatively few Hindus, as compared with Muhammadans, were found blind. This was accounted for by the Muhammadans receiving help and assistance from their countrymen, while the blind Hindus, no doubt, had their lives cut short down parapetless wells, or under heavy wheels in narrow village lanes. He was sanguine enough to believe that Christian sympathy would be extended, and that a very different result would shortly appear. He had been told by one native—Muttra Brahmin as he was—that time was not to be spent in meditation; and he started over India searching after a god, and at Agra, before the Mutiny, the late Bishop of Lahore was preaching, it was under his preaching that the Brahmin found the God whose service he entered. This man had since faithfully served God, and was now the master of a large school, and was carrying on a work quietly, of which the outside public knew nothing, and doubtless there were many similar cases. If they could only carry on the work in the spirit which the reader of the paper had advocated, of Christian sympathy and love, there would be no fear of the result. No one could doubt but that there was a great future before the Muhammadans, and Sir Syed Ahmed was *the* man who would give it the required impetus, on the right lines.

Sir Charles Turner also expressed his obligations to Sir William Hunter for his interesting paper, and expressed his concurrence in much that the reader had said as to the features of the two religions in India of which the adherents were most numerous. He agreed that each of these religions exerted a marked influence on the social life of its votaries. Instances of these influences were afforded in the evidence collected in the recent inquiry into the qualifications of natives of India for employment in the public service. The Hindu religion, while embracing many sects, imposed on all its followers the obligation of obedience to the head of the family, to the caste, to the spiritual teacher, and to the traditions of sages. While these restraints were unfavourable to original thought, and repressed individual energy, they habituated Hindus to law and order, and inspired respect for constituted authority. The administrative ability displayed by their Hindu colleagues would, he felt sure, be admitted by Englishmen who had taken part in Indian government. On the other hand, the creed of the Muhammadan fostered to a greater degree in the individual self-confidence, energy, and a habit of command. In almost every department regret had been expressed by witnesses that so few Muhammadans had qualified themselves for employment by the study of English. The energy of their influential teachers was, however, overcoming the disinclination of their co-religionists to European education. Of the Muhammadan witnesses examined in the Punjab and elsewhere a substantial number had expressed their views very lucidly in the English tongue. The attraction which the Muhammadan religion exercised on the out-caste, to which Sir William Hunter had alluded, was illustrated by what was now taking place on the Malabar coast. The agricultural labourers, who, previous to British rule, were slaves, were raised, by embracing Muhammadanism, from the despised position of Pariahs. An interesting explanation of the success of Muhammadanism among the less civilised races would be found in an article by M. Valbert which recently appeared in the *Revue des deux Mondes*, on a work by Mr. E. W. Blyden. Time would not allow him to say much on the portion of the paper which dealt with Christianity in India. He would only remark that he agreed with Sir William Hunter in the expectation that there, as elsewhere, it would raise the position of woman; and that he could not doubt it would produce a purer and higher altruism than was possble to the caste system of the Hindu, or the fatalism of the Muhammadan.

Mr. W. S. Seton-Karr had listened with a great deal of pleasure to the tribute which Sir William Hunter had paid to the work done by the three Serampur missionaries, but regretted that, by accident no doubt, their names had been omitted. The names of these three great men were Marshman, Carey, and Ward. He should not attempt to follow the reader of the paper into all the interesting questions which had been raised, thinking it best on an occasion like the present, where the field was vast, and the subject had been so admirably dealt with, to confine his observations to that part of the subject on which he had some special and practical knowledge. He would say a few words about the position of the Muhammadan population of Lower Bengal. He was lately reading Sir William Hunter's own account of the Muhammadan population of Lower Bengal, and

he found it stated that there were 17,000,000 to 18,000,000 of Hindus. He agreed with the reader of the paper in his view of the early conversion of the Muhammadans, and their rise in the social scale, but he thought more allowance should have been made for summary conversion; 600 or 700 years ago the green flag of the Mussulman, the Koran, the sword, and despotic rulers had a great deal to do with their rapid conversion. When he served in Lower Bengal he paid a great deal of attention to the state of the Muhammadan population, and he agreed with the remark that a large portion were tillers of the soil. He had been much struck with the inferiority of Muhammadans as agriculturists as compared with the old Hindu castes. He did not quite admit that Islam was a teetotal religion, for to his knowledge and observation there was a good deal of drunkenness among the Muhammadan population; they had also adopted divisions of castes, and relapsed into Hindu practices. He did not know whether any gentleman had noticed an anonymous article in the "Contemporary Review," stating that all Muhammadans were potential soldiers, but he believed that there was not a single Muhammadan of Central or Lower Bengal to be found in the Bengal Army. At one of the large Hindu festivals, viz., the passage of the Juggernaut car, he had noticed a much larger proportion of Muhammadans than Hindus. Those who wished to find a mine of knowledge upon Indian subjects had only to refer to the "Imperial Gazetteer," lately published by Sir William Hunter.

Dr. LEITNER agreed with Sir William Hunter in his protest against subjecting intellectual and moral worth to a money standard, a tendency which seemed to have become almost part of the English character. Neither religion nor caste could be gauged by this standard. The reader of the paper had brought forward an opinion on the subject of caste which deserved the greatest consideration, and the gratitude of those who were interested in India, whether their standpoint was that of Orientalists, the improvement of the people, or the promotion of missionary enterprise. He thought it was only by the adaptation of native methods that it would be possible for Christianity or the Government to strike such root among the people of India as would give the promise of future development. It had been said by Mr. Seton-Karr that the promotion of Muhammadanism in India was due to violent methods, and that he had seen a great deal of drunkenness among Muhammadans, but to both of these remarks he begged to offer his respectful remonstrance. It was owing to Muhammadan tolerance that he was allowed to enter a mosque school.

Mr. SETON-KARR said his remarks applied to Lower Bengal.

Dr. LEITNER said that showed that speaking of India as a whole was a great mistake. As to the statement that Muhammadan propaganda was carried on 600 years ago mainly by means of the sword, all he could say was that he did not agree with that view. He thought the success of Islám was due to its intrinsic merit. It was the first duty of Muhammadans to promote and protect the worshippers of the religion of the one God. Temperance was the great weapon which Muhammadans had wielded throughout the world, and it was this weapon that Sir William Hunter wished to place in the hands of Christian missionaries. The subject of caste had been most ably touched upon by the reader of the paper, but further investigation was still required before the British public would appreciate it in respect to its effect on Indian society, and as the one feature by which the future civilisation of India would be worthy of its past renown and its present British rule. The Christian Lutheran converts who kept caste were manlier than the others, and the explanation which had been given to him was that it was because their heathen brethren took care of their sons and daughters. He knew some Hindus use the prayer-book of the Church of England for their devotions, and otherwise obey the caste observances. Caste did not interfere with progress in any way; it came to the same thing as that gentlemanly feeling which Englishmen of all classes were supposed to reverence. Any native who had any respect for himself would think twice before he attacked that great bulwark of Indian society. Sir Alfred Lyall had pointed out that Hinduism was encroaching on backward races. Hinduism, however, did not take the alien individual away, and give him no public opinion to rest upon. There was a great misconception existing, even among those who had made India their speciality, with reference to the question of infant and widows' marriages; infant marriages, as practised amongst high-caste natives, was the gradual dedication of the child towards its spiritual marriage.

The CHAIRMAN said there was one thing they must all be agreed upon, and that was in giving their most sincere thanks to Sir William Hunter for his exceedingly eloquent and able paper. He supposed (and the speakers who had addressed them that night had shown that what he was going to say was right) that it would have been impossible for Sir William to have chosen a more difficult subject than the one on which he had addressed them. To endeavour in the short space of this paper to give anything like a summary account of the social and political conditions of the different religions in India was certainly a task which would demand the highest abilities of a lecturer. When he heard the paper he was surprised at the extraordinary ability with which Sir William Hunter had condensed in so short a time almost all the important characteristics of the subjects which he had put before them. The subjects were so vast that he thought the speakers that evening had done well—and he should follow their example—in not endeavouring to make any general

criticism on the paper. A paper required to be read carefully before discussing it, as each particular part had been carefully studied, and it would require a dissertation to put before any assembly any difference of view which might be entertained upon any part of the large subjects which had been discussed. What had struck him in listening to the paper —and he dared say it had struck many others—was that there was probably no Government in the world with respect to which such a paper could have been read, because he supposed there never was, in the history of the world, any Government which had held a position of entire fairness between the different religions existing in India. Sir William Hunter deserved the greatest credit for the impartial manner in which he had given them his views with respect to the extension of Christianity in India, abstaining carefully as he had done, and as it was his duty to do in that room, from giving that warmth of expression to his own opinion on the subject, which, doubtless, he would give before another audience. He was not going to discuss any of these difficult questions. He thought that Lord Ripon, and his other friends, would agree with him that all those who had had the good fortune to be connected with the Indian administration owed a deep debt of gratitude to the Indian gentlemen of all religions, with whom they had worked. There were very many distinguished Hindus whose names would occur to all who had been in India, who had been of the greatest service to the British Government. There were first Sir Dinkar Rao, and next Sir Madhava Rao, who were the great leaders of Hindu society at Calcutta. Perhaps the ablest native was Raja Ramanath Tagore, who was no doubt the authority to whom Sir William Hunter had alluded when he referred to the Hindu going back to the original doctrine, in respect to many questions which were from day to day decided with regard to the life and manners of India. There were many others whose names would be in the recollection of everyone who had been always ready to give their assistance to the Government of the day. Among others was Sir Syed Ahmed. When he (the Chairman) went on a mission to Egypt, some years ago, he asked Lord Ripon to send out, to be attached to his staff in India, a Muhammadan lawyer of distinction who might assist him in communicating with the Egyptian Government upon legal matters, and Lord Ripon was kind enough to assist him by sending out a most able judge, Samallah Khan, who rendered most valuable assistance to the mission. He thought he should not be doing justice to his feelings with respect to the assistance given to the Government by the religious communities in India without saying that there had been religious bodies in India that had rendered important assistance to the Government. Among others, Dr. Duff, of the Free Church Mission, than whom no man gave a higher impetus to education; Dr. Wilson, of Bombay, who had attained the respect of the residents, and had greater knowledge of that part of India than any European who was alive at the time. He mentioned these two, but there were many others who, quite apart from their religious work, had been of the greatest use by their advice to the natives of India and the Government upon matters of politics. He was almost ashamed, upon such a subject as this, not to be able to address some observations more worthy of acceptation, but he felt the great difficulty of the questions which had been raised, and how little one knew of the inner thoughts and life of the different races and religions. On so grave a matter the wisest course for any one to take was to listen with respect and attention to the information which was given by so high an authority as Sir Willian Hunter, to ponder over the most interesting problems that had been put before them, and to carry away with them the feeling that the development, both of the Muhammadan and Hindu religions, was certainly in the sense of liberality and enlightenment, rather than drawing tighter the bonds of exclusiveness, which at one time appeared more likely to take place; and further the reflection that it was probable, if any great development of Christianity should take place in India, that that development was more likely to come from a native side than from the adoption of any particular phases of Christianity which were known in Europe. That such a development might come at a future time was the anxious desire of all Christians, and it was certainly not inconsistent with the history of the development of religions in the East, nor could it be said to be at all improbable that before long some huge wave of religious feeling might be excited, and extend over the vast Indian Empire.

The vote of thanks having been carried,

Sir William Hunter said that if missionaries wished to make Christianity really a part of India, they must study the history of the past. If they did so they would find that wherever Christianity had taken root, it had been in the agriculture of the country, and in the communal institutions. The work done by the different societies had led in some places to the reclamation of waste land, and to the growth of a prosperous population. The Chairman had remarked that no Government but England would govern India so fairly, and with this remark he agreed, but there was something more to be said. He did not know any subject at this moment in England, except that of India, which would have brought together men of so many different opinions, who had come out on that cold and bitter night to testify by their presence to their enduring interest in India and in the Indian people. This was a true tribute from England to India, that men who were divided in public life on great and serious questions, felt that they were united in their love for that distant country in which they had served.

TWELFTH ORDINARY MEETING.

Wednesday, February 29th, 1888; Prof. Sir HENRY ROSCOE, M.P., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Oates, Rev. Alfred, Christchurch Vicarage, Ware, Herts.
Stannus, Hugh, F.R.I.B.A., 61, Larkhall-rise, S.W.
Statham, Henry Heathcote, 40, Gower-street, W.C.
Tough, John James, 13, Benthall-road, Stoke Newington, N.
Tunley, George, 3, Foley-avenue, Hampstead, N.W.
Weevers, Richard, Woningworth, Fulwood-park, near Preston.
Whitely, George, 733, Commercial-road, E.
Whiteley, Richard William, 1, Friar's Stile-villas, Richmond, Surrey.

The following candidates were balloted for and duly elected members of the Society:—

Bainbridge, Herbert J., Malvern-hall, Solihull, Birmingham.
Beaufort, Leicester P., M.A., B.C.L., 3, Paper-buildings, Temple, E.C.
Brown, Joseph, Q.C., 54, Avenue-road, Regent's-park, N.W.
Hussey, Frank T., The Portman Estate Office, The Grove, Cheddon Fitzpaine, Taunton, Somerset.
Wilson-Barker, David, 66, Gloucester-crescent, Regent's-park, N.W.

The discussion on Mr. Swire Smith's paper on "The Technical Education Bill" was resumed.

Mr. DANIEL WATNEY said that no one could be more adverse than he was to the idea that machinery caused a diminution of employment, for he was persuaded that without the multiplication of machinery there would be starvation for a great number; but he could not help sympathising to some extent with the doctrine that labour was merely a commodity to be bought and sold. He regretted to say that Mr. Smith's paper contained many contradictions, which led to much confusion of thought. From the elaborate system of education, founded on a foreign model, which Mr. Swire Smith proposed, and which would need for its development a prodigious number of professors, one might suppose that this country was far behind all other countries in the education necessary for artisans engaged in manufacture; but in the same paper they read that England was the great industrial pioneer; that her artisans had no rivals abroad for energy, thoroughness, and general efficiency; that in the foreign workshops the best machines were of English make, or copied from English models; that a great number of the manufacturers abroad had received their education from Englishmen; and that though sometimes the article produced abroad might appear at first sight superior to those made in England, yet on closer scrutiny it was found that the advantage was with Englishmen. Even protection was cited as a sign of inability to compete with Englishmen; so that in non-manufacturing countries, in spite of the keenness of competition, Englishmen held the field. It was admitted that foreign workmen were employed for longer hours and at a lower rate of pay than English workmen, but unless it could be shown that in the distribution of profit the foreign master got a greater share than his English rival, they might almost conclude that the low wages of the foreign workmen were a measure of the value of his work, and it was not for us to show the methods which led to such an unsatisfactory end. With reference to art, the South Kensington system supposed the possibility of teaching so much art as was necessary for a special purpose, in contradistinction to the system of employing those only who had been thoroughly well educated as artists in special work. Sir Henry Cole advocated and adopted the first system, and Ruskin always recommended the second. He was in favour of Ruskin's view, but whichever was the right one it was perfectly evident that the number of artists required would be infinitesimally small in comparison with the elaborate changes proposed to be set up by the new school of professors. Technical instruction was defined to be instruction in those branches of science and art which received, or would receive hereafter, grants from the Science and Art Department—those branches would hereafter include commercial subjects (whatever the expression might mean) and modern languages. The absurdity of including modern languages among technical instruction was so great that he should not take up time in considering it. After much research he had failed to find out any principle in Mr. Smith's address, unless it was that one which he might call a forlorn hope, namely, the rights of man. If so, he supposed it might be stated thus:—Every child born unto the world had a natural right to be passed up from the elementary school to the secondary school, and from secondary instruction to the greatest facilities for acquiring scientific, artistic, and industrial skill and knowledge. Secondary schools would have to be regulated through the elementary school by a system of examinations and scholarships, and the best boys would obtain the scholarships. It was reasonable to suppose that those who attained scholarships would be raised one step in the social ladder, and be on the way prepared to be ladders of science. There were opposing causes at work now by which the number of ladders would constantly decrease.

Mr. WOODALL, M.P., differed from Mr. Watney, when he said that Mr. Smith's opinions were

characterised by contradiction and confusion, inasmuch as whilst he showed undue admiration for foreign models, at the same time he had paid considerable compliments to our own country, and spoke of its superiority in many matters. Now, we might acknowledge the advantages we still retained, and yet recognise the important strides which had been made by continental competitors. It was gratifying to know that in many departments our superiority was still almost unchallenged, but no one engaged in any important manufacturing industry to-day was unaware, with regard either to continental or neutral markets, that they had to reckon with competition infinitely more severe and more intelligent than they were accustomed to some years ago. Some of the industries in this country had been absolutely saved from extinction by the adoption of foreign machines. The trade of corn grinding, for instance, he believed had fallen into the lowest stage, and had only been saved by the adoption of the skilled machines of Austria and Hungary. He doubted if every newspaper printed in London was not produced by means of either French or American machines; certainly with regard to paper-making we had been greatly indebted to the ingenuity of foreign engineers. Mr. Smith had paid great attention to the conditions under which these industries were carried on in foreign countries, including the rates of wages, the hours of work, and the standard of living, and, whilst giving due importance to those conditions, he had maintained that they did not altogether account for the advantages gained by some of those countries. Within the last few days, he had received a communication from Mr. Schoenhof, the American Consul for the Staffordshire Potteries, who had been studying these matters on the Continent, and who had established to his satisfaction that the higher the rate of wages the lower the cost of production. Fifty years ago our position was uncontested, and we were essentially the manufacturers of the world, but at the present moment we had been driven back from most of the continental markets, although it was still true that we held in France a position superior to that held by Germany, and in Germany a better position than that held by France. In fact, in any protected country our position was superior to that of any competing protected competitors; and from the recent statement of Mr. Giffen, it appeared that with regard to the chief of the neutral markets our position was one of considerable advantage even yet as compared with foreign competitors. It was important, however, to remember that our rate of progress in some markets, whilst not actually retrograding, was smaller than that of many of our competitors, and we had to consider what it was which gave them that comparative advantage. He had not heard his friend Mr. Smith's paper, but would undertake to say that every statement there made was unquestionable, and he thought they might feel assured that the countries which had made the most remarkable progress were those which had devoted themselves with the greatest zeal to the furtherance of their educational systems. Who would look to Switzerland as a great industrial country, possessing as she did no natural resources beyond the wood growing on the mountains, and the water which rushed down from the glaciers. She had no coal, and was so far from the sea that she had to traverse numerous hostile countries before getting her raw material home, or her manufactured products to the market. Yet they all knew what a remarkable position she had taken in the manufacture of everything which called for great skill on the part of the employer and the workman. Especially in the great industries upon which the Chairman was so well able to speak, Switzerland stood simply unchallenged. Take, for instance, the manufacture of dyes to be used in the delicate colouring of silk products. Switzerland had absolutely no natural advantage, and was handicapped at every turn, yet they took from England the coal-tar products, which went through a stage of development in Germany, and then went through the further refinement in Basle, and found their way back to his friend, Mr. Wardle, at Leek, to the silk dyers at Lyons, or the silk manufacturer at Milan. How was that explained? In one of the factories which he went through with Sir Henry Roscoe he found 300 workmen, and there were ten laboratories, in which competent skilled men from Zurich were constantly employed in producing new colours and seeing them carried out to commercial success. That was but one of a hundred illustrations of the way in which the absence of natural advantages was compensated for by the cultivation of brain power. In that particular canton, from the primary school to the Polytechnic school and University, education was systematised and encouraged by public money and public interest. The predominant political passion of all classes was the furtherance of these ends, and they produced the results he had named. In one point he could agree with Mr. Watney, that we must look at this question from a practical point of view, and that it should not be a question of mere bookishness. There was in England, on the whole, a very symmetrical system of education over a considerable range of subjects. The elementary system was good from many points of view, and, although there was a great deal to be said against the system which had its centre at South Kensington, there was a great deal more to be said for it. If there was one fault, it was rather that it erred on the literary side from a want of practical application to the direct needs of the time. If they could only give the boys and girls in elementary schools, by the development of the great principle which lay at the base of the Kindergarten system, an intelligent and real conception of the purpose for which they were taught in its application to the needs of life, something would have been done, and if a little more of this

practical spirit could be ingrafted into the South Kensington system, it would go a great way to make perfect a system which already had very great merits. But they were on the eve of great strides in this respect; valuable services had been given towards directing the teaching to the need of the times by the City Guilds, but their end would not be obtained unless there was not only development of public sentiment in its favour, but of such a practical influence of that sentiment upon Parliament as would make them determined that nothing should be spared either in the direction of individuals, or in the expenditure of public money, to give to the people those "rights of man" which Mr. Watney deprecated.

Mr. W. ANDERSON, as an engineer and manufacturer, who had taken an active part in the administration of the Elementary Act, said he rejoiced to find that so much was being done, at any rate in the way of talk, in getting an extension in education and carrying it on a little further, and he hoped before long they would see the fruit of these efforts, and above all a more liberal expenditure of money, such as their continental neighbours were making. In considering the rank and file of the great industrial army, he thought they were rather running the risk of forgetting the officers. A complete change was wanted in this respect, and in the admirable lecture which the Chairman delivered before the British Association he particularly referred to a change being made at the top as well as at the bottom. It seemed incredible that a practical nation like England should administer to the young men who were rising up, and who were going to be the masters and leaders of industry, a uniform pabulum of dead languages, which, to the greater part of those educated, would be of no use hereafter. Science was completely neglected, and also the study of modern languages, which was of the utmost importance to trade. He was not such a Vandal as to find fault with the teaching of dead languages, but he thought they had not time now to let the whole early life of young men be devoted to studying dead languages, and leaving them afterwards to acquire the knowledge which they ought to have in the pursuit of business. He was fortunate enough to have been born in St. Petersburg, and to be brought up in a commercial school, which was founded by a syndicate of native and foreign merchants, who had discovered that children required to be educated in a manner suitable to their needs. In this school the boys were classified according to scientific knowledge. They were taught arithmetic, mathematics, natural philosophy, chemistry, botany, political economy, history, geography, and all sciences which in after life would be useful to them in every transaction. The whole afternoon was devoted to modern languages —Russian, French, English, and German, two periods of an hour and a half each day being devoted to two languages. In addition to that, there were three ushers, an Englishman, a German, and a Frenchman, who were on duty on alternate days, and the language of the school was the language of the usher of the day, the consequence being that each boy could read and write four languages. To that grounding in modern languages he chiefly owed his success in life. In the struggle in which they were engaged from the competition abroad, partly from protective duties and other causes, it behoved them not to neglect a single thing which would enable them to take a foremost place. The German and Swiss were far ahead of the English, but no doubt the establishment of science colleges was now doing something to remedy this evil. The men trained in the schools at Manchester, Sheffield, Leeds, and elsewhere were as well brought up as the Germans, and considering that they were Englishmen, it was more desirable to employ them than foreigners. He rejoiced that the effort was being made to spread abroad the knowledge which was so essential to progress, and he only hoped that it would be extended not only to the lower ranks of society, but also to the upper.

The CHAIRMAN said there was one point which Mr. Anderson had omitted to refer to, namely, that in his practice he found the idea that English people were not quick in picking up foreign languages was quite a mistake. There was no reason why Englishmen should not excel in the study of foreign languages.

Mr. ANDERSON said in his opinion Englishmen were particularly fitted for acquiring a knowledge of foreign languages, and English mechanics who went abroad on any job were generally able to make the natives understand them in about six months. He had had a great number of young men from Harrow, Rugby, and Eton, and he found that they knew English imperfectly, while as to the other languages they knew nothing at all about them, although they went abroad to foreign countries as engineers.

Dr. GLADSTONE, F.R.S., said he had had the advantage of hearing the paper of Mr. Swire Smith, and could only say that, in rising to speak upon it, he could only do so in the way of commendation as to all the general principles laid down, as they were founded on the greatest knowledge of the subject, and the recommendations, on the whole, were such as thoughtful men must be led to. He might mention one or two points on which he differed from the conclusions put forward, and he should commence, not at the top but rather at the bottom, namely elementary schools. Mr. Smith made various recommendations as to how technical instruction might best affect elementary schools, and he (Dr. Gladstone) was inclined to think that he might have made still bolder recommendations. If he only knew what was going on at the London School Board, he would have been bolder in some of the points. In infant schools

Mr. Smith spoke about the enlargement of the Kinder-garten method of instruction, and that was a subject which everyone felt must come on. Kinder-garten principles were being adopted in almost all directions, and it was quite easy to extend the principles so as to lead up to technical instruction. There were, perhaps, two different directions in which the principles might be extended. One was in the direction of scientific subjects, because the first thing children learnt was about natural objects, and the Kinder-garten took hold of that, and gave a knowledge of nature. The object lessons should not stop in the infant school, but should be continued all through the upper schools, becoming more and more systematic as they proceeded, and, of course, more scientific. The principles which underlay the various specific scientific subjects should be engrafted in the minds of children. The next thing was in the instruction of the eye and of the hand, and the various senses, so as to develop the various powers with which they were endowed. This could be done by means of cards, or little peas, or straws, and higher up by modelling in clay and sand, and ultimately in wood. It ought not to be a rule of thumb, but children should be trained up in early years, so that they might feel sure they were treading upon accurate ground, and that every step they were making was in the way of progress. He would include drawing in colours, because little children did not see things in outline. Mr. Swire Smith stated that the system of elementary science should be encouraged in the upper standards; but what was wanted was that it should proceed from the infant school right on towards the upper standards, and that it should be a regular and systematic development. Then they were told that the use of simple manual tools, during the last year of schooling, should be taught; but he did not know why the knowledge of tools should be confined to the last year of schooling; it would become more and more employed in the latter part of schooling, but it should be gradually introduced as the children became older. If it was restricted to the last year of schooling, depend upon it a large number of the artisan population would never get any of it. The instruction should be given to those who would be the common workers in life; but very often this class would have to go without it if the education was confined simply to the upper standards, as this class would rarely remain at school long enough to reach the upper standards. Girls should be taught domestic economy experimentally and scientifically. In all schools the perceptive method should be made to enter into the different lessons. He thought they might direct a good deal of school machinery towards industrial pursuits; for instance, in many of the schools they had small museums containing objects of interest, in some of them not only natural history objects but very good illustrations of various industries of the neighbourhood and of other parts of England. In the Board School nearest to his house he saw the other day many specimens of wood, and the different modes by which it could be worked. There were blocks ready prepared for wood engraving, wood mosaic was illustrated, and there were vegetable products used in the arts, including illustrations of the cotton manufactures. and a good collection of jute from the rough material to the finished state. This might be carried out in all the various school museums. They were to introduce manual instruction into schools; but at present they met with a difficulty as to direct work, and the use of tools was not acknowledged by the Education Department, so that they were dependent upon the charity of the City Guilds. One or two other experiments were being carried on in the schools, but certain gentlemen were responsible for the expense of the wood that was used. The City Guilds had nobly come forward and afforded the means of carrying out experiments in six different places in London, and he had no doubt whatever that their effort would be duly appreciated, and that they would receive the reward that was due to them in this respect. With regard to the coming Bill, he hoped it would be somewhat on the lines of the previous Bill; but it would be a pity if it was confined to children who had passed the Sixth Standard. If it was confined to these, a very small proportion of the scholars would receive the advantage of it. Mr. Smith and others had spoken of continuation schools being free, but that was a matter which needed some consideration, because it was doubtful how far it would meet with the general approval of the people. Some might think that as those who attended continuation schools were on the road to earning wages, they might pay something towards the expenses of the school, and this would remove, to a certain extent, the objection which he had heard in some quarters. With regard to voluntary schools, he scarcely saw the difficulty. Suppose the Education Department made manua instruction either a class or specific subject, then there would be a certain good Government grant attached to it which would be quite sufficient to meet the ordinary expenses, and then both voluntary schools and Board schools might fairly introduce it. Continuation schools afterwards would be common to whoever chose to go to them, from whichever class of school they came. He did not therefore feel that there was any serious difficulty in this respect.

Sir Owen Roberts said that having been associated with Mr. Swire Smith for many years in connection with technical education in Yorkshire, he had very few causes of difference with him; he might truly say from what he knew of him that he had thoroughly got his facts together, and these facts could not be impugned by anybody. If people proceeded on well ascertained facts, the conclusions were, as a rule, also well digested and reasonable. With regard to the recommendations as to the coming Education Bill, he was happy to hear that

they were agreed to by Dr. Gladstone. He thought they could never have a good system of education until the elementary system was such as to lead up to it. He agreed with Dr. Gladstone that it was useless to begin with elementary science when children arrived at the Sixth Standard, as a very small proportion of pupils ever reached that standard. It was useless to begin then, unless they had a continued progress from early stages. He had the advantage the other day of reading a draft of a report of the School Board, and he read it with great delight. By-and-bye, he supposed, it would be submitted to the public gaze, and when that report was published it would create great pleasure in the minds of those who were interested in the question of technical education. The conclusions of that admirable report were, in the main, very similar to the views which Mr. Swire Smith had advocated, and he cordially hoped that when the Technical Education Bill of the Government came to light, that it would follow the lines indicated in that report. There were many technical evening schools in Yorkshire, and he hoped that similar ones would be established in other parts of the country. As to the great bulk of the population, the necessities of life were so rigorous that boys must plunge into the competition of life at an early age, and therefore they could only be taught by means of evening classes. There must be university and technical colleges in the centres of industry, but in villages he hoped evening classes would be formed on the advanced Kinder-garten system, if he might so call it, which would direct the application of science to the industries prevailing in those neighbourhoods. That system, if it was one thoroughly grounded in agricultural and industrial centres, would be a grand thing.

Professor GARNETT said Mr. Woodall and Mr. Anderson had called attention to the necessity for educating industrial officers, but he thought that more than one case could be cited where a whole trade had left a district, and workmen were thrown out of employment, not through any fault of theirs, but simply on account of the want of knowledge on the part of the masters, the managers, and foremen. He knew of one case where a large industry had practically deserted the Tyne; he would not say it was on account of the fault of any particular class of persons, but it was because other processes had been invented elsewhere, whilst the processes employed in that district were the same as they were when introduced forty years ago. Another industry now bid fair to be established upon a small scale, though he was not in a position now to go into the particulars respecting it, though he might state how the industry had developed. No less than four gentlemen, doctors of philosophy of German universities, had been employed to work up the processes to be carried on in connection with that industry. It was almost impossible to find men of sufficient training in this country, so that it had been necessary to introduce gentlemen from German Universities to work up these elaborate systems. Whenever he attended a meeting of engineers at Newcastle to discuss scientific papers, the necessity was forced upon them of a public laboratory in which experiments could be conducted by engineers for the sake of enlarging their knowledge of the materials with which they had to deal, and they were constantly coming upon questions which needed further experiment, but at present they had to rely upon the public spirit of private firms or companies to allow of the investigations being conducted in their works. This showed the necessity for high teaching and institutions in which the higher kind of work could be carried on for the sake of enlarging the bounds of science. Passing to the other extreme of the scale, it was important that the training in elementary schools should be brought more into touch with the practical life of the boys who were afterwards going to earn their living by what they learned in the school. The system was at fault very much on account of the manner in which the grant was administered in elementary schools. There was such a tremendous premium put on the passing of a very large proportion of the students in reading, writing, and arithmetic, that, except in a few of the schools in the largest cities, class subjects were very much neglected, and specific subjects were absolutely neglected. It paid the school better to pass 90 per cent. of the boys in reading, writing, and arithmetic, than to pass 80 per cent. in those subjects, and to add a number of scientific subjects. Looking through the Blue-book, if he excepted physiology (which, as far as the first year course was concerned, consisted of teaching the Latin names for various parts of the body) and cookery, nearly all specific subjects were absolutely neglected. About 3,000 out of nearly 400,000 who might have taken these specific subjects took electricity and magnetism, and only 1,300 heat and light. What was wanted was to bring the teaching more into harmony with the practical life of the workshops. Boys should be brought up to meet the problems they would have to face in after life. The Kinder-garten system might be enlarged very much, but there was considerable difficulty in introducing the manual instruction in schools; at any rate he was sure that vast masses of the industrial population in the north of England would look with suspicion upon any proposal to introduce the tools of any particular trade into elementary schools. They talked a great deal about manual training; but supposing they put into the hands of a boy a chisel, a hammer, and a file, what did it mean? It meant teaching him to be a fitter, and nothing else. Engineers said they could teach boys the trade in the workshop in six weeks better than it could be taught during six years at school. That was quite true. How could they by possibility teach all the trades, and why should they employ public funds, in the shape of Government grants, to further the teaching of joinery and fitting, as against all the host of trades

which had a claim upon them. If in primary schools boys were taught drawing, so as to make a complete set of descriptive drawings of a simple piece of machinery, by means of a pocket rule and a pair of compasses, the scholars would learn more valuable information than if a large portion of their time were spent in learning the use of particular tools. In the higher grade schools, tools might be given to boys out of school hours, and that was done to a certain extent by some School Boards, but it might be further developed. One other point was this, when boys reached the age of 15 or 16, and evening continuation schools had come to an end, if they entered apprenticeship classes in which they were to be taught the technology of a particular trade, or the handicraft of a trade, it was an admission that the apprenticeship system was not complete. If it were found to pay better to assist in the formation of evening schools, in which certain branches of trade have to be taught, than to introduce special instruction in the workshops, under these circumstances, it was only fair that employers should pay, at any rate, the current expenses of conducting these classes. In Newcastle there were two trades being taught in that way, and employers had come forward to be responsible for any deficiency in the amount required in teaching these classes. It was a pure waste of public funds to teach a clerk enough plumbing to mend a water-pipe in his house. The teaching of specific trades must be limited to the members of those trades; and if a boy came with a letter from his master, saying that he was *bonâ-fide* in the trade, he was taught it, and no opposition had been encountered from trades' unions; in fact, they supported the classes in every way, and would do so if the conduct of these classes were carried on under a committee consisting partly of employers, partly of foremen, and partly of journeymen.

Sir Philip Magnus said Mr. Smith had worked out in detail a great many of the recommendations of the Royal Commissioners on Technical Instruction; but so much misunderstanding still seemed to exist on the matter, that he might be allowed to summarise them under three heads. In their journey through foreign countries those Commissioners came to these conclusions—first, that the education of the captains of industry, the overseers of factories, was very much better abroad than in this country, and one of their main recommendations was as to the desirability of encouraging the higher scientific instruction of those who had to take charge of industrial works. A great deal of misunderstanding arose from the use of the word "technical" as applied to education. It was not found that professional education abroad was much more developed than in this country, and the Commissioners did not recommend the establishment of professional schools, but rather the raising generally of the character of education. They all recognised, as Mr. Watney had said, that technical education was possibly of most importance to those who had to take charge of industrial works. Technical education had a direct benefit upon industry so far as it concerned the masters, and it only indirectly benefited those who occupied the lower rungs of the industrial ladder. In nearly all of the special industries in which we had been beaten by foreigners, it was owing to the fact that the higher technical education of those engaged had been better cared for abroad. It was not supposed that the higher scientific colleges of the country would be benefited by the Technical Instruction Bill, nor was it, on the whole, desirable that they shonld be. It was desirable that higher education should be supported by subsidies derived from the Imperial Exchequer, and should not be dependent on grants raised from local sources. There were a large number of such colleges in different parts of the country, and one of the most important was the institution recently erected by the City and Guilds of London in Exhibition-road, the object of which was to give the higher education the want of which was generally acknowledged. As regards chemical industries, to which reference had been made, their success was almost entirely due to the superior scientific knowledge the Germans and Swiss obtained in the Universities and Polytechnic schools, and not to any special professional training. The next conclusion at which the Commissioners arrived was that the general education of all classes of the people, particularly in Germany, was superior to that in this country. In an address delivered five years ago, he stated that one of the great advantages of this cry for technical education would be, that it would have the effect of revolutionising our present system of education, from the primary school up to the University, and would substitute for it a practical education, the elements of which would consist mainly of mathematics, science, and modern languages. These subjects formed the backbone of industrial education, and should run through the whole system in various degrees, from the elementary schools to the highest. One other conclusion of the Commissioners was, that in France to a great extent, and in Germany to a less extent, but generally on the Continent, art education was very much more developed than in England. He was pleased to find that Mr. Smith had devoted considerable attention to the importance of the encouragement of art education by the State. The industries into which art entered were those in which the foreigner was beating the Englishman. They were often asked the use of teaching drawing indiscriminately to all children, and the answer was that designers might be selected from those who were likely to be actually engaged in different trades. The elements of art education should be spread broadcast, so that from those who had received that instruction designers might be trained. There was an additional advantage in giving art training to those engaged in various handicrafts, that it would tend

to combine the artisan and the artist, as was the case in former times. It was desirable to make a designer out of the man who was originally an artisan, so that he might understand the adaptability of his material to his design, and not out of a professional artist. He deprecated very strongly any exaggeration of the superiority of foreigners. It was a fact that, in nearly all branches of trade except the few to which he had referred, England at present held a position of commercial supremacy. But they wanted to retain that position, and what they noticed abroad was not that the Germans, French, or Swiss had generally surpassed us, but that these nations were gradually creeping up to us, and they hoped that, by taking the matter in time, to ascertain the causes of this improvement in foreign trade. It was sometimes said that there was not much good in educating the majority of workmen engaged in different industries, but that every factory should have associated with it two or three highly skilled scientific men, who would be able to guide the work. The answer to that was that an educational machine was wanted which should have for its object to catch ability wherever it might be found, and this applied equally to the teaching of science and of art. It was not expected that very many would be able to apply the little science they had learned, but if they taught science to a thousand artisans, and even one was able to make some good use of it, the money would not have been spent in vain. Nothing was yet known about the forthcoming Technical Education Bill, but they could not expect that it would give any encouragement to the teaching of special trades, and he therefore felt that there would be in the future an equally wide sphere of useful action for the City of London Guilds as there had been in the past.

Mr. McLaren, M.P., said he entirely agreed with what had already been said with regard to elementary education, and in spite of Dr. Gladstone's condemnation of free continuation schools, he sincerely hoped that such schools would be free. It had been found on the Continent that the drawing schools were free, and it was a very great inducement to the people to have these free schools, especially if means were found for compelling young men to attend them. With regard to technical education, he should be exceedingly sorry if what Sir Philip Magnus said were true that it should only deal with elementary education or what was immediatly above it. He did not mind so much whether Government gave the grants, but unless the Government were prepared to allow municipalities to create technical schools, the Bill would fall hopelessly short of what the public expected.

Sir Philip Magnus said he only referred to what might be expected from the Imperial Exchequer.

Mr. McLaren said, as a matter of fact, the Government had already taken an important step in advance in the way of making grants for technical instruction. During the last Session, Parliament granted £1,000 for starting a dyeing, spinning, and weaving school in Donegal, and he did not see why the same should not be done in England. Again, it had granted for years past £4,000 a-year for dairy and agricultural education in Ireland, and a departmental Commission had lately been appointed which had reported in favour of making a grant of £15,000 a-year for the technical education of dairy farmers in England. He did not see why the same should not be done for manufacturing industries; but if municipalities were allowed to do this they might rest content. It seemed to him, above all things, necessary that technical and commercial education should not be eft entirely to voluntary effort; the plan Mr. Smith had proposed should be insisted upon. Either the municipalities, School Boards, or local Boards—as to the exact machinery it was not important—should have the power of spending money out of the rates in support of the technical education connected with the trades of the district. They should be allowed to appoint on their committees for managing such schools men in the locality who were specially interested in the subject, and qualified to superintend the schools. If the municipality alone or the School Board took the matter in hand, the schools would not be so managed. In the case of Bradford or Keighley, they wanted men who had given special attention to the subject, who would manage the schools much better than town councillors or members of the School Board. They did not want to have South Kensington interfering in the details of technical education. If it were left in the hands of local authorities, with building grants from the Government, he thought that would be sufficient. With regard to other branches of education, such as drawing and science, all classes of the community could unite in paying taxes for these things, and he trusted they would do all they could to see that the Bill was a satisfactory one, and that it would give the local authorities every possible power for spending as much money as they thought fit.

Mr. Reynolds (secretary of the Manchester Technical School) said he was very glad to have the opportunity of saying a few words, if only to express his thanks to Mr. Smith, whose paper had done very much to systematise the discussion on this question, as to which there was a very considerable vagueness in the public mind. On some of the points he did not entirely agree with him, and of these the one of most importance was that relating to free instruction. The school of which he was secretary had 2,600 students, 2,300 of whom were earning students, and they paid in fees about £1,500 per annum. He did not see why the public should lose the benefit of the fees to that extent. Out of the large number who came to the evening classes in

Manchester, nine-tenths could easily pay the fees demanded, and whilst that was so, and whilst the fees represented but a fraction of the expenses, he thought that those who gained such a benefit should contribute some portion of the expenditure involved. With regard to teaching trades, Professor Garnett had said that there was some opposition on the part of working men in Newcastle to that being done. It was of very great importance to give youths in Board schools the opportunity of some manual instruction; but he did not agree that it should be given at a very early age. His experience was that it could not be usefully given to boys under 12 or 13, for until that age boys were quite unable to use the tools required. It should not be the object of a school simply to make a joiner, but to train a boy to use his eye and hands, and hence the instruction should be of a thoroughly systematic character. Not long since, he was in a large standard school in a town in the Midland counties, celebrated for its success in teaching science and earning grants. In that school there was a manual training department. So far as science was concerned with the object of earning grants, the instruction was of a thorough character; but where no grant was earned, the use of tools was as bad as it could be. Unless instruction was given on a system properly organised, with a thoroughly qualified teacher, it was worse than useless, as it simply trained the lad to be a bad workman; but if the lad were taken step by step, and taught the use of every tool, the reason why it had the shape it had and why he worked with certain tools, and certain materials, and if the instruction were accompanied by scale drawing, and the lad had to make plans, sections, and elevations of everything he did, the training would be satisfactory. Hundreds and thousands of our population found their way to the Colonies, and unless they could be sent away with some power of using their hands, they were as useless in Melbourne, or in the Far West, as in Manchester or London. He thought whatever objection trades unions might have to training boys to the use of tools, the public advantage from it was simply enormous. Again he would remark that every boy could not be intellectually a success, but in the Manchester Technical School, where manual training was given, it was found that boys who would be hopeless failures in mathematics or languages, turned out exceedingly clever with their fingers, and in this way they might be quite as useful. In that school they found an enormous difficulty in the evening classes, that a large number of youths came eager to learn the principles which underlay their various trades, but they were so little prepared in drawing and arithmetic that they were unable to take advantage of the instruction offered, and very often they were obliged to be taught the elements of instruction, in order that they might profit by the instruction they required in their particular trades. A line should not be drawn too closely as to who should go into a practical class. A short time ago a plumber applied at their schools for a youth whom he might instruct in his business who could use joiners' tools. Everybody knew the extraordinary way in which plumbers went into a house, pulling up the floors, and so on, to lay their pipes, but why should not a plumber be allowed to learn the use of joiners' tools. To say that only those should go into a practical joinery class who intended to be joiners, was a great mistake. He wished Mr. Watney could have some experience of the vigorous North, and then he felt sure he would change his mind on most points. There was the greatest eagerness on the part of youths in Manchester and other towns to profit by opportunities of learning the principles of the various trades, and they only wanted the chance at a moderate price of getting this instruction from proper teachers, to take eager advantage of it. Mr. Watney spoke rather disparagingly of what he termed the rights of man. He thought these had been too long neglected, and, at any rate in Manchester, people were waking up to a conception of what they conceived to be the rights of man. A committee had been established in Manchester with the object of starting an organisation, to be called the Institute of Art and Industry. They proposed to put at the disposal of that committee a quarter of a million, to establish an efficient technical school, an efficient art school, and a thoroughly well-organised industrial museum. They intended to ask the help of the corporation, and then came the question who was to have the control of the institute. Was it to be the corporation, who were expected to find the money to maintain it, or to be a combination of the corporation and the men who were practically interested in the matter. He believed that if the control of schools of this country were placed in the hands of School Boards, which had enough to do already, or in the hands of Town Councils, which already had the multifarious duties of managing a great town, and both of which bodies were too frequently elected on sectarian political considerations, it would be a mistake. It was of the greatest possible importance that merchants and manufacturers who were so largely interested in the management of these schools should be associated with the Town Council in the management; if not, they would become merely dilettante concerns of very little practical use to the country at large. Sir Philip Magnus had alluded to the fact that the Science and Art Department would not concern itself with technical education, but if so, what was the meaning of the minute issued by the Educational Board with regard to technical schools in Scotland? That clearly contemplated the establishment of technical schools by School Boards in Scotland. He thought that would be a mischievous thing. The onus should be thrown on the locality to establish technical schools suited to its peculiar needs, and they ought to be so managed and arranged that they

should not depend on a grant for their success. If they did, only such subjects would be taught as paid. Teachers soon found out the weakness of the examiners and dropped those subjects, however needful, which the examiners were hard upon. The aid given should not depend on the number of pupils who passed through the net of an examination, but there should be some system whereby a sum should be given dependent on the number in attendance, on the efficiency of the teaching, the equipment, and the general good management of the school. That might be secured by a real system of inspection, whereas the inspection of the Science and Art Department in the main was a farce. There was no real inspection, and until there was there would not be any guarantee that the teaching was efficient.

Prof. SILVANUS THOMPSON said the last speaker's remarks had evoked a strong response in his own breast, for it had been much on his mind lately, what would be the harm effected by an injudicious Bill such as that of last year. For years they had been asking for bread, and last year they were offered a stone, and he was now told they were to have this year offered the same stone again, only turned over. Mr. Swire Smith had said he wished to evoke public opinion in favour of a measure which would more adequately meet the necessities of the case; he quite agreed, but he thought they had far better have no Bill at all than such a one as that of last year. He had talked this matter over with a large number of men who, like himself, had been engaged more or less actively in technical education, and they were all convinced it would simply do harm if they had such a Bill. With all Mr. Swire Smith had said about half-time schools, evening schools, and so on, he entirely agreed, but where he diverged was where it was proposed to put them under the thumb of the Science and Art Department. They were asking for education and instruction, and they were offered instead examination and cram; a system which led to superficial instruction in a lot of subjects and thorough instruction in none, or next to none. He was not speaking without experience, for he had been a student under the Science and Art Department, and had had to cut himself adrift from it. He had tried to teach under that Department, and had again to cut himself adrift from it. He had done his best to use the scheme which the Government had given them, a scheme which might have, and indeed had, been a great success for the spread of elementary teaching of abstract science and of abstract art, but it was quite a wrong scheme for real technical education. They wanted a proper reorganisation of technical education, with a Minister at the head, and a proper council to take charge of the various branches. He did not want to interfere with the Science and Art Department, which had done so well in its own sphere, though cramped by the unfortunate system of payment by results, but would leave it where it was, reform it, and possibly enlarge it; but he would not put technical instruction under it. The Chairman took the position that the Bill of last year was correct, and that you could not draw the line between the examinations of the Department and of the City of London Guilds. With regard to the latter system, he had nothing to do with the examinations, although he had the honour of being in charge of a certain portion of the educational work of the Institute. As the Finsbury Technical College did not prepare students for any examinations, either of the Science and Art Department or of any other outside body, he could speak the more frankly on this question of examinations. If the Technical Instruction Bill passed, it would not effect them at the Finsbury Technical College in any way; they would simply go on as they had done; teaching what they thought best, in the way they thought best, without regard to grants, examination, cram, or anything of the kind. Thanks to the munificence of the City of London Guilds, they were in an independent position, and were not tied to the tail of any State examinations or any code. His objection to the Science and Art Department being intrusted with technical education, as well as with education in science and in art, was a radical one. Their whole system of certificating science teachers and art masters, which might be very well as long as only children had to be taught, would break down utterly the moment they attempted to apply it to the technical training of workmen. Such teaching must be essentially by specialists. They were attempting to do that which could not be done; they attempted to manufacture an article called an art master to teach art, and another kind of article called a science master to teach science, and thought when they had an art master properly labelled and turned into a school of art, that was all that was wanted except a code and a set of examinations. Just the same with the science master. Was there ever such a miserable attempt at an educational system? Of course, he was putting the case in a nut-shell, and it might be inaccurate in detail, but it was true on the whole. The art master was educated by a system which drove out all real art from him. He was put through a certain mill, and, if he had any technical knowledge of any one art-industry, it was ground out of him, and he was told to neglect all applications of a technical kind. No credit was given for technical excellence of execution in the work of students sent in for national competition. If a wood carving was sent in for the national competition, there was no heading under which it could come, though this was a thoroughly English art; the examples were judged simply as so much "raised ornament," as though they were clay, the adaptability of the form to the material being absolutely neglected.

The CHAIRMAN said there was a school of wood-carving in South Kensington.

Professor THOMPSON said that was not under the Science and Art Department: that, from amongst the subjects recognised for national competition, or for the certificate of an art master, wood-carving was excluded. In fact, all round in the art industries, any application which required knowledge of the material and a special adaptation of design to the material was virtually set on one side. No value whatever was given to the technical execution of the work sent in, but the thing was judged simply as an ornament. Was that the way to encourage a workman to become a designer? It was the way to raise up a designer who knew nothing about the work it had to be applied to. The same thing was still more true in science, and he invited the Chairman's special attention to this, for no one was more capable than he to speak from the chemical point of view. He believed that, in chemical industries, it was true that the higher the absolute scientific training, the more perfect would be the advantage of the trained man in the chemical industries; but he did not think that the same absolute relation between abstract science and its applications existed in other departments. Take the science of geometry. If they took any Cambridge tripos man, who had, therefore, the highest training in the abstract science of geometry, and put him down to teach a lot of metal-plate workers, or carpenters, or brick-cutters the way to lay out their patterns for metal-cutting, or to cut the bricks for groined arches, or to devise the peculiar geometrical arrangements for any complicated roof, would the highly-trained Cambridge man be of any use? Absolutely none; he would rather take an intelligent carpenter who knew something of drawing. The complete inability of the man who merely knows the abstract science to teach its application in technical operations, as exemplified in the case of geometry, was true in a great many other instances. The South Kensington system was most fatal to the actual training of the workman; the science they could learn, such as it was, under that *régime*, was of very little use to them. What was the result of this system. In trying to create a universal science teacher, they created a man with a little superficial knowledge on a lot of topics, who would never take his students outside the limits of the code. Little cram-books came into use, written from a narrow range of knowledge, with absolutely nothing in them but what was required to fit the code. What did the Chairman think of a cram-book in chemistry which professed to teach analysis as far as was required for a certain stage of the code? which, when it came to the second group of metals, (those which ought to go down in an acid solution by passing sulphuretted hydrogen through them) carefully left out copper, the most important metal of all, simply because it did not happen to be in the syllabus. It was like teaching the alphabet, and when you got to the letter "e," leaving it out because it was not in that particular part of the code. That was the kind of thing obtained by payment for results and cramming for a code. Until that wretched system was wiped out, he did not believe in putting technical education under such conditions. To take a man because he had some proficiency in two or three branches of science, and imagine he could teach every branch, and much more, that he could teach the technical application of all those, was simply absurd. About fourteen years ago he had tried to take advantage of the opportunities offered by the Science and Art Department—and as he knew some physics and a little chemistry—tried, by passing a lot of the May examinations, to get a scholarship to take him up to the Science and Art Department's Normal School. He got the scholarship, and then he was told that he must go into Professor Huxley's laboratory, and learn physiology. He had nothing to say against Professor Huxley's laboratory; no doubt it was the very best of its kind, but physiology was aot in his line. He had wanted to study chemistry and physics, and to make himself really competent in these subjects—in fact, to become a specialist really qualified to teach them. But he was told that, as he was weak in physiology, he must go into the physiological laboratory to be made a wholly competent science teacher all round, in order that he might be able to teach classes in physiology. As he did not want to be made into an all-round superficial dabbler, he threw up his scholarship and stuck to physics and chemistry. Was that a system which would turn out teachers competent to give instructions such as the workmen of England want, in the technical applications of science to the industries? The Science and Art Department's notion was to get men who could teach everything—building construction, machine construction, steam-engines, chemistry, mining, zoology, naval architecture, botany, physics, and everything else. That was the sort of science teacher they turned out; a man who taught everything, but knew nothing thoroughly. That was in his opinion the very antithesis of what technical education ought to be. If they wanted to thoroughly condemn technical education, there was no surer way than to pass such a Bill as would hand technical education over to the system of cramming for examinations under teachers who knew nothing of the industries.

The CHAIRMAN said Professor Thompson had made a very spirited attack on the Science and Art Department, but there was a good deal to be said for the Department, and if time had allowed, he should not have been disinclined to take up the cudgels in its favour, but he must now call on Mr. Smith to reply.

Mr. SMITH, in reply, said he was thoroughly repaid for all the labour he had taken in preparing this paper since it had led to so admirable a discussion.

The question had been treated from various points of view, but every speaker had made a real contribution to the question, and, at any rate, if they did not agree with what had been said, they could see there was very much in the remarks which had been made. At the conclusion of the paper he had said he had no doubt there would be considerable difference of opinion with reference to a question of this kind which was looked at from different standpoints, but still he thought the discussion had brought them closer together than they were before. He thought that the best reply he could give to the several remarks would be to ask the speakers to re-read the paper, and in nine cases out of ten it would be found that the differences of opinion had been very much anticipated. With regard to the crucial part of the question, he asked that localities should have power if they thought fit to do certain things, and although it was not likely that localities would rush into a great expense in imitating their German and French competitors in the building and equipping of great schools, still perhaps here and there a locality would be emboldened to make some steps in this direction, and no doubt the good example would be followed, and thus we should gradually have the question carried beyond the experimental stage, and be able to see the effect of the work which would thus be inaugurated. Probably the strongest objection was with regard to free night schools. He made that suggestion because the experience of the Commissioners abroad was that throughout France, where probably the best art schools in the world existed, all the evening schools were free. They were very largely attended in Paris, and the same applied to Belgium, Switzerland, and most parts of Germany. All the great evening schools he had visited, such as they wished introduced into this country, were free schools, and all who were practically engaged in this work—in promoting teaching in large towns—found that the fee was the great question of difficulty. They were most anxious that those who would most benefit by this instruction should not have any impediment thrown in their way, but, of course, on this subject there would naturally be differences of opinion. With regard to the remarks of Professor Silvanus Thompson, he would say that it would be an exceedingly good thing if they could have, in all towns, Finsbury Colleges established amongst them, and if there were some authorities who would provide by munificent endowments the deficiency between the income and expenditure; and if, on the other hand, they could have the benefit of the very best of teachers. If that were so, they would not ask the Government to do anything; but when he spoke of the Science and Art Department, he referred to the only organisation there was in England at the present time for promoting science and art instruction of a national character; and, although he was much impressed with what Professor Thompson had said, it brought to his mind many examples of an opposite character. Although there were many defects, yet it was marvellous the effect which had been produced by that Department in many towns in the North. In the Birmingham School of Art, the teaching might not be the most effective, but they were informed that, 25 years ago, there were no English designers in that town, and no superior English workmen in any of the great works; that Messrs. Elkington had 25 foreigners, and in many other works they had foreign workmen for all the leading positions. At the time when the Commissioners visited Birmingham, however, such had been the influence of the Birmingham School of Art, that at Elkington's there were only two foreigners, and about the same proportion in other establishments. In Nottingham a few years ago, the whole of the lace designs were produced by foreigners; they either imported foreign designers or foreign designs. but at the present time the inspiration was almost entirely English, and the Commissioners were informed that this was due almost entirely to the influence of the School of Art. In his own town of Keighley, the school of art and science classes had educated all the foremen or leading men in the several industries. He hoped what Professor Thompson had said would go to the Department, and would influence public opinion; still they must admit that the influence of the Science and Art Department had wrought wonders in many industries, and very much of the position we held at the present time in those directions in which we had made any tangible improvement, had been due to the influence and teaching of that Department. The great thing which he hoped for from the Bill was, that power should be given to localities to do what they thought best for themselves, but he had gone fully into that, and need not dwell upon it longer. Mr. Reynolds said it was no good to give power to School Boards or municipalities, but they must remember that the power which found the money must also have the responsibility of controlling its expenditure. If they asked the Government for money, they must give the Government the control, and if they asked the municipalities for it, they must have full representation, in order that the ratepayers might see that their money was not squandered. Dr. Gladstone's view was, that science teaching and manual instruction should begin as early as possible, and that the Kinder-garten system should be carried out throughout the whole school, and he was bound to say that he sympathised very much with him, but he remembered that the Government Bill only started with the 6th Standard, and he feared that the public would be frightened if he asked that manual instruction should begin at so early an age and go right through. In the North, where they had many half-timers, there was a strong feeling that the time at present was quite little enough for dealing with the ordinary reading, writing, and arithmetic, and that any overloading of subjects would only defeat its own end. Mr. Watney's remarks had not

been of a very seriously damaging character so far as the question under discussion was concerned. He evidently would not accept the rights of man theory so far as to give to a man all he was capable of receiving, not only for his own benefit but for the benefit of the community at large; but it was doubtful whether very many would agree with him. He (Mr. Swire Smith) thought that the more discussion they could have of the character they had had that evening, the nearer they would come together in opinion, and their united influence would be all the greater in hastening a solution of this great question.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Swire Smith, which was carried unanimously.

Professor JOHN PERRY, who was unable to speak on account of the length of the discussion, writes:—"With the Bill of last Session I mainly agree. No one is so ready to express his obligations to the Science and Art Department as I am. I owe much of my education to it, and think that it may be improved in its machinery sufficiently to perform the functions required from it by the Bill. But it has been well said that unless the lower classes interest themselves in this subject very little good can be done. Now, what steps have been taken to obtain the votes of working men for this measure? I was apprenticed for seven years, and worked at the bench with workmen; in virtue of my great sympathy with the workers, I ask you to take their sentiments from me. Because we speak badly and incoherently, and there is much rubbish in what we say—it is all the more your duty to find out the essential truths underlying all we say. Not one speaker last night hinted at these truths. Much was said about improving our industries, building up the apparent material prosperity of Great Britain. The workers acknowledge that machinery cannot be destroyed, that 'bad trade' simply means bad methods of doing business and old-fashioned machinery; that on account of machinery ten skilled workmen are employed now for every one employed fifty years ago; that the poorest man can now have luxuries such as Queen Elizabeth could not buy. But the workers see something more. For every skilled workman you have now twenty unskilled men. A youth spends his years in turning a few handles, turning out beautifully-finished objects by the hundred; and this would all be very well but for the poor youth himself. What sort of a man will he become? Machinery enables England to support a huge population, but of what use is this if every unit of the population is a slave to machinery? Machines are becoming more and more self-acting; more and more they require that the offices performed by men shall be menial. More and more machines are becoming self-productive. I cannot accentuate too strongly the fact that unskilled labour is rapidly increasing in this country, and that the only way in which machines can be kept as the slaves of men rather than as their masters is by cultivating more and more the intelligence of the men. With your schemes we are in sympathy. You are weaving a huge net, which will seize upon any embryo Faraday and give him a chance of development. One Faraday in every twenty years would repay all your trouble. You will also recruit the middle class with units from the lower classes; this is of enormous importance, as these units can tell you what the lower class needs. But you are not educating the bulk of the lower classes. Your methods are academic. You think that reports from Germany and France will help us, and I, an old workman, an old manager and employer of labour, a technical college professor, tell you that this is an English problem, which must be solved by English methods. Do you know what sort of men come to evening classes? You, from your balloon-like position, think they are common men, perhaps a little more priggish than their fellows. I who teach evening classes tell you that these men are heroic martyrs, who sacrifice citizenship, and necessary social pleasures and courtship, for a very small gain of knowledge. Sometimes I see a man sleeping in my lecture-room. I remember in the meal hour falling asleep over the "Binomial Theorem," and when, after working hard from six to six, I went home, I sometimes could not possibly avoid falling asleep over my books. One of my present students does not reach home till midnight, and has to get up at 4 a.m. to go to his work. If this young man lives he will meet the success he deserves. I highly approve of small fees, or rather having no fees whatsoever. But is it possible to expect this sort of work from all young men? Place a youth near a good workman in the shop and he is in the best possible position for learning manual skill. But is it not possible to design some machinery to compel a master to see that the youth learns the principles underlying his trade? I have spoken about this now for many years, and workmen continually speak of it, but our legislators and academic speakers on technical education are still oblivious to the really important problem. A youth gets only a few shillings a week, much less than the value of his work even at the beginning. Is it fair to make him work from seven to six, like the workmen, and say that, unless he attends regularly an evening class for four nights in the week (and less time is nearly useless), he is to remain ignorant of his trade. I say that the master ought to be compelled to give him technical education during at least two hours of every working day. (See my letter in *The Electrician*, January 3rd, 1880.) The success of the old model school system in Ireland showed that it was possible to give a sound education, including elementary, practical mathematics, experimental mechanics, physics, and chemistry, freehand and mechanical drawing, and one modern language to boys of 13. (See my evi-

dence three months ago before the London School Board.) It is absolutely necessary that this, or some equivalent, should be given in primary schools. It can be given in such a way, by even poorly-paid teachers, that children take an intelligent interest in all their school work. This letter is already too long for me here to give my objections to workshop teaching in schools. It will probably, in the long-run, be given in regular school hours. It will in any case be badly given. Regarded as a training to the hands, eyes, and bodies generally, it is not nearly so good as experimental mechanics and drawing in school hours, combined with top-spinning, marbles, hoops, and other usual plays carried on outside school hours. If a boy is to become a pattern or cabinet maker or fitter, I think that his work in a school workshop will prevent his ever acquiring skill in a real workshop. A public school workshop is a good thing. In 1870, when science master at Clifton College, I established the first school workshop in this country; it is still a very thriving institution, but the circumstances and functions of primary schools are essentially different from those of the public schools. Workshops in primary schools will add enormously to the unskilled labour in the country."

Miscellaneous.

ANNATTO CULTIVATION IN GUADELOUPE.

Annatto thrives in Guadeloupe at an altitude of 500 to 600 metres, but yields less and less as the distance increases above 400 metres. Consul Bartlett says that in cultivating it, it is not necessary to plough the land, but holes are generally dug to plant annatto. These holes have a diameter of fifty or sixty centimetres and thirty or forty centimetres in depth. According to the state of the soil, they are set at a distance of about three metres, and of four metres if the soil is a rich one. The seeds are laid in the ground at once, a few seeds in each hole, and later on, one of the strongest shoots is left to grow and all the others are pulled up. The young plants require a careful hoeing around them for nearly a year on the whole extent of the plantation. In nurseries the seeds are sown in well prepared beds, at a distance of about thirty centimetres between each row. These beds are carefully attended to for several months, and when the young plants have attained a height of about forty to sixty centimetres they are placed singly in each hole. The soil around the young seedling is carefully attended to in order that weeds should not take possession of the holes and destroy the young plants. The plant grows very fast, requiring little care after the plantation has attained a certain size. It blossoms one year after being transplanted, and bears a few pods, but is far from having reached its full size, which may be four to five metres. In a rich soil the trees will meet each other at a distance of four metres, and will shade the whole ground in four or five years. The ground is hoed at least two or three times a year, until the trees have attained their full size. Annatto bears twice a year, the spring blossoms always yielding the largest crop. As soon as the pods in the bunches commence drying and opening, the bunches are cut by means of a pair of shears or a crooked knife. These bunches are packed in baskets and transported to the shed prepared for the purpose. Consul Bartlett says that this is the most tedious part of the cultivation, every pod requiring to be picked with the hands, as much as possible the seeds attached to the white film inside being left untouched. The pods when empty are used as manure. This work of picking, in Guadeloupe, is generally performed by women and children, who are paid at the rate of about five centimes per kilogramme. The crop is gathered from the 15th of July until the end of August, and it is estimated that one hectare of annatto (the hectare being equivalent to 2·47 acres) should yield on an average 1,500 kilogrammes of green seeds for the two crops, or about seven casks of pulp, weighing from three hundred and fifty to four hundred pounds each.

PRODUCTION OF MANGANESE IN CHILI.

The Belgian Minister at Santiago, in a report to his Government, says that the first manganese deposits in Chili were discovered about eight or ten years ago at Mansee, a distance of six miles from the hospital station of the southern railway. These beds were bought and worked by an English company. For some years, the results were very satisfactory, but the deposits then began to give out, and the working expenses increasing very considerably, it was considered advisable to stop work. Towards the north, the first deposits discovered were those in the province of Coquimbo. This mining centre, which is called *Corral quemado*, is situated at a distance of 18 to 20 miles from the railway from Coquimbo to Rio Grande. The mines are connected with the railway by a good carriage-road, and the ore is carried to a station on the line which is situated about sixty miles from the port of Coquimbo. There is another station called the Penon, at which the ore is delivered, and by which the distance to Coquimbo is reduced to 36 miles, but by this route it is necessary for the ores to be carried a part of the way on the backs of mules and the rest in waggons. The excessive cost of this method of transport renders it almost impracticable. The expenses of putting the ore on board at the port of Coquimbo, including the extraction, the

transport by waggon and rail, and the loading charges, are, on the average, about 15 piastres per ton, the piastre being equivalent to about two shillings. The monthly production of the mines of the province of Coquimbo is estimated at between 3,000 and 4,000 tons, all of which is exported directly to England, and it is expected that they will continue to be worked for many years. In the Department of Freirina, forming part of the province of Atacama, deposits of manganese are found at Picanitas, about thirty-six miles from the port of Carrizal Bago, which are stated to be very valuable, and have only recently been worked. The bed of ore is of great richness, and extends for a considerable distance. The principal mines are the *Porvenir-Resbalon*, *Mirada*, and *Negra*. Analyses which have been made of these ores, both in Chili and England, have given the following results:—Manganese, 48 to 56 per cent.; silica, 11 to 12 per cent.; phosphoric acid, 8 to 10 per cent. at the most; copper, none. During the month of February, 1887, the first cargo of ore from this mine was shipped from Carrizal Bago, and since then deposits have been actually worked, and with very good results. A carriage-road, from twelve to fifteen miles in length, connects the mines with the Chorillos Station, on the Carrizal railway. The total cost for extraction, transport by road and rail up to the shipment at the port of Carrizal Bago, varies between eight and nine piastres the ton, according to the position of the mines. If, says the Belgian Minister, a line were constructed, at a cost of 40,000 or 50,000 piastres, from the Chorillos Station to the mines, on which trucks could be drawn by horses, this cost would be reduced to five or six piastres a ton. If this were done, it would facilitate the transport and working of the deposits, which would easily amount each month to 4,000 tons, but at present the monthly output does not, owing to the lack of facilities of the means of transport, average more than 1,000 tons. There are in the same department other deposits of more or less importance, but their workings have not yet commenced. At Chanaral there are also manganese mines, but no reliable information is available as to their importance or situation. The manganese mines of the provinces of Coquimbo and Atacama are the only ones which, up to the present, have been systematically worked. The Belgian Minister, in conclusion, says that the development of this industry is checked by the absence of purchasing firms. Many persons who would otherwise engage in it find it impossible to work the mines on their own account and ship the ore to Europe, owing to the lack of the necessary capital. When, however, the value and importance of Chilian manganese is understood, and direct purchases of the ore are effected in the same way as with copper and silver, an impetus will be given to this industry, and the discovery and working of fresh deposits will aid considerably in its development.

SEA-SHELL INDUSTRY OF SINGAPORE.

Consul Studer, of Singapore, in his last report on the trade and industries of the Straits Settlements, says that for receiving and shipping sea shells of great variety in colours, forms, and sizes, Singapore is very important; and a great many kinds of shells which a few years ago were only bought by travellers, naturalists, and collectors of curiosities at nominal prices, are now eagerly sought after and bought by agents and firms for shipment to Europe and the United States, where they are used in the manufacture of a variety of articles. They are received in Singapore from all parts of the Indo-Malayan Archipelago, the Coast of Siam, Burmah, and China. They are divided into three classes—mother of pearl shells, assorted shells, and green snail shells. Mother of pearl shells are almost entirely received in Singapore from Borneo, the Suloo Islands, and the South-Eastern Archipelago, including the Moluccas. Assorted sea shells are neither imported nor exported by weight, but in almost any way they can be bought from the natives. There is much guesswork as to quantity in buying them, as they are nearly always bought by the boat-load or basket, or in the case of the rarer ones, by the hundred or thousand, if counted into assortments. In exporting them they are nearly invoiced per assortment at so much per thousand. In the year 1885 the value of assorted shells imported amounted to £2,500, and of those exported to £2,800. Green snail shells are a land shell, strictly speaking, of short spiral form, about one inch long, and of about five-eighths or three-fourths of an inch in diameter in the thickest part. In colour they are a pale green, suffused with yellow. They are common throughout Malaysia, but the Mergui Islands, on the west coast of Tenasserim, contribute a large proportion of those exported—nearly one third. Consul Studer states that, some years ago, these shells, beyond purchases by naturalists and curio hunters, did not enter into commerce at all, but they gradually found their way into commerce for export, to be made into small buttons for kid gloves. They are exported almost exclusively to Austria, France, the United Kingdom, and the United States.

Obituary.

Dr. Badger.—The Rev. George Percy Badger, LL.D., who died on Tuesday, 21st February, was a member of the Society of Arts since 1874, and also an active member of the Foreign and Colonial Section. Dr. Badger was born in 1815, at Chelmsford, and spent his early life at Malta. In 1841 he took orders in the Church of England, and was appointed by the then Archbishop of Canterbury

and the Bishop of London, delegate to the Eastern churches, more especially to the Nestorians of Kurdistan. In 1852 he published his work on "The Nestorians and their Rituals." He was for a time Government Chaplain in the Bombay establishment, and subsequently chaplain at Aden. In 1857 he was appointed Staff Chaplain and Arabic Interpreter to the Persian Exhibition under Sir James Outram, and in 1861 he again accompanied Sir James Outram on an important visit to Egypt. He was the author of several books, but his chief work was the English-Arabic Dictionary, which he published in 1881.

Notes on Books.

ELECTRICAL INSTRUMENT MAKING FOR AMATEURS. By S. R. Bottone. London, Whittaker and Co. 1888.

The object of this little hand-book is to provide those who are professedly unskilled in the use of any tools whatever sufficient to enable them to construct, at all events, rough apparatus for experiments in electricity. Perhaps a little more handicraft skill than Mr. Bottone gives his readers credit for possessing is necessary, and certainly a larger array of tools than he specifies would be very desirable. Such works are, however, of value in leading those who may have the requisite faculties, but have not had any opportunity of employing them, to direct their attention to scientific matters, and afterwards to carry their studies to more advanced regions than those in which the author's students are supposed to inhabit. There are probably very many science teachers who, though themselves more advanced, will be grateful for suggestions as to the utilisation of simple materials in the construction of apparatus, and such will find Mr. Bottone's book useful. There are many simple pieces of electrical apparatus, such for instance as the ordinary electric bell, of which no notice is taken, and which might certainly have taken the place of others which, when constructed in so rough a manner as described, could certainly not be expected to do any useful work, and might only too probably serve to mislead the student, or to discourage him by their failure.

General Notes.

TYPE - WRITING MACHINES.—Colonel Stuart Wortley, Keeper of the Museum of Machinery and Inventions (Science and Art Department), writes to the Secretary of the Society, that Sir Charles Wheatstone's type - writers, referred to by Mr. Trueman Wood in the discussion on Mr. Harrison's paper (see *ante* p. 354), are now in the Museum. Some of these instruments were given by Sir Charles Wheatstone, and others by his executor, Mr. Sabine.

BOOKBINDING EXHIBITION.—The cloth covers, with original designs by Mr. William Morris, Mrs. Orrinsmith, and the late Mr. Dante Rossetti, described in the *Journal* (p. 377), were lent by Messrs. J. Burn and Co.

GEOLOGICAL MAPS.—Sheet 7 of the Geological Survey Maps, showing the Drift, was published in 1871, so that the statement in the note on p. 394, col. 2, should read eight years after 1863, and not fourteen years. On page 393 the scale of Smith's map is given correctly as five miles to the inch, but in the note the scale is misprinted as five inches to a mile.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 7.—"Framework Knitting." By W. T. ROWLETT.

MARCH 14.—"Technical Instruction in Agriculture." Prof. JOHN WRIGHTSON.

MARCH 21.—"The Evils of Canal Irrigation in India, and their Prevention." By T. H. THORNTON, C.S.I., D.C.L. Colonel Sir OWEN T. BURNE, K.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 20.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

APRIL 24.—"Craftsman and Manufacturer." By LEWIS FOREMAN DAY.

MAY 8.—"What style of Architecture should we follow?" By WILLIAM SIMPSON.

MAY 29.—"Persian Textiles." By CECIL SMITH.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 6.—"South African Gold Fields." By W. H. PENNING, F.G.S.

MARCH 27.—"The Panama Canal." By J. STEPHEN JEANS.

APRIL 17.—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D. Sir WILLIAM W. HUNTER, K.C.S.I., LL.D., will preside.

Cantor Lectures.

The Third Course is on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By John Mayall, Jun. Two Lectures. The second lecture will be delivered on Monday evening, March 5.

Dr. Mann Lectures.

Two lectures will be delivered by Professor Oliver J. Lodge, D.Sc., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. John Mayall, Jun., "The Modern Microscope."

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. L. B. L. Druce, "A Government Department of Agriculture."

Royal Institution, Albemarle-street, W., 3 p.m. 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Henry Faija, "The Effect of Sea Water on Portland Cement."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. Alexander M. Chance, "The Recovery of Sulphur from Alkali Waste by means of Lime Kiln Gases."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. F. A. Walker, "Oriental Entomology."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Edward Freshfield, "Glimpses into the Parochial History of the City of London, as gathered from the Records." (Lecture II.)

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. W. Dundas Gardiner, "Points in the Law Relating to Ancient Lights."

Tuesday, March 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. W. H. Penning, "South African Goldfields."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture VIII.)

Central Chamber of Agriculture (At the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. R. A. Hadfield's papers, (1.) "Manganese in its Application to Metallurgy;" (2.) "Some Novel Properties of Iron and Manganese."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Prof. G. B. Howes and Mr. W. Ridewood, "The Carpus and Tarsus of the Anura." 2. Mr. R. Bowdler Sharpe, "Description of some new Species of Birds from the Island of Guadalcanar in the Solomon Archipelago, collected by Mr. C. M. Woodford." 3. Mr. G. A. Boulenger, "Note on Classification of the Ranidæ." 4. Mr. Frank E. Beddard, "A Species of Worm of the Genus *Æolosoma*."

Wednesday, March 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. T. Rowlett, "Framework Knitting."

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Prof. Tout, "The Welsh Counties."

Institute of Bankers, in the Theatre, London Institution, Finsbury-circus, E.C., 7 p.m.

Entomological, 11, Chandos-street, W., 7 p.m. Messrs. George C. Griffiths and William F. White, "Experimental Observations upon the Colour-Relation of the Pupæ of *Pieris rapæ* to their Immediate Surroundings."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W. 8 p.m.

United Service, Whitehall-yard, S.W., 3 p.m Captain W. Crutchley, "The Condition of the Mercantile Marine—*Personnel* and *Matériel*—considered with a view to its more complete Utilisation and Reserve for the Royal Navy."

Thursday, March 8...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Charles Stewart, "Sound-Producing Organs in the Animal World."

Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. H. Dallinger, "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life." (Lecture I.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. R. von Fischer Treunfeld, "The Present State of Fire Telegraphy."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, March 9...United Service Inst., Whitehall-yard, 3 p.m. Major-General J. Michael, "The Native Army of Madras; its Constitution, Organisation, Equipment, and Interior Economy."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Leslie Stephens "S. T. Coleridge."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. Students' Meeting. Mr. Alfred Chatterton, "The Prevention and Extinction of Fires."

Astronomical, Burlington-house, W., 3 p.m.

Quekett Microscopical Club, University College, 8 p.m. Special Exhibition Meeting.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. B. Dawson, "Shakspere's Accentuation of Proper Names."

Saturday, March 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Dr. Mann Lectures.) Prof. Oliver J. Lodge, "Protection of Buildings from Lightning."

Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. G. L. Adden-broke, "A Reflecting Galvanometer." 2. Mr. Herbert Tomlinson, "A Theory Concerning the Sudden Loss of Magnetic Properties in Iron and Nickel at a High Temperature."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Experimental Optics." (Lecture VII.)

Journal of the Society of Arts.

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FRIDAY, MARCH 9, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE ALBERT MEDAL.

By command of the Queen, the Council of the Society of Arts attended at Buckingham Palace, on Thursday, 8th inst., when H.R.H. the Prince of Wales presented to her Majesty the Albert Medal, and read the following loyal address of the Society of Arts :—

To the Queen's Most Excellent Majesty.

We, your Majesty's most dutiful and loyal subjects, the Society for the Encouragement of Arts, Manufactures, and Commerce, desire to offer to your Majesty our sincere congratulations on the completion of the fiftieth year of your Majesty's auspicious reign, and to express an earnest hope that your Majesty may yet for many years be permitted to receive the affectionate homage of your people throughout your Empire.

Your Majesty is aware that this Society has during many successive years presented to persons who have rendered eminent services to Arts, Manufactures, and Commerce, a medal, named after the illustrious Prince whose enlightened patronage and far-seeing counsel so greatly helped and furthered all the objects which the Society was founded to promote.

To the list of eminent persons whose services have entitled them to the award of the Albert Medal, the Society now wishes to add the name of the Sovereign under whose just and beneficent sway all classes of her subjects have been enabled to enjoy the advantages which the progress of science and the arts has afforded. We therefore humbly pray your Majesty to permit us to mark this eventful year by offering the Albert Medal to your Majesty, in commemmoration of the advance of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of your Majesty's reign.

ALBERT EDWARD P.,
President.

Sealed with the Seal of the Society for the Encouragement of Arts, Manufactures, and Commerce, this eighteenth day of July, 1887, in the presence of (L.S.)

DOUGLAS GALTON,
Chairman of Council.

H. TRUEMAN WOOD,
Secretary to the Society.

Her Majesty then handed to the Prince of Wales the following gracious reply :—

"It gives me much gratification to receive your loyal and dutiful Address, on the occasion of the completion of the Fiftieth year of my reign.

"I accept with pleasure the Medal which bears the name of my beloved husband, and which you offer me in commemoration of the advance of Arts, Manufactures, and Commerce, throughout the Empire during my reign.

"I trust that success will always attend on the Society of Arts, in their efforts to promote the enlightenment and the progress of my people, in those important matters which so nearly concern their welfare and happiness."

The following Members of the Council were present :—Sir Douglas Galton, K.C.B., F.R.S. (chairman), Sir Frederick Abel, C.B., F.R.S., Mr. W. H. Barlow, F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., Sir Edward Birkbeck, Bart., M.P., Sir Frederick Bramwell, F.R.S., Mr. Alfred Carpmael, Mr. R. Brudenell Carter, F.R.C.S., Mr. B. F. Cobb, Sir Daniel Cooper, Bart., K.C.M.G., Sir Juland Danvers, K.C.S.I., Professor Dewar, F.R.S., General Donnelly, C.B., Sir Henry Doulton, Colonel A. C. Hamilton, Sir Fredk. Leighton, Bart., P.R.A., Sir Villiers Lister, K.C.M.G., Mr. G. Matthey, F.R.S., General Sir Henry F. Ponsonby, K.C.B., Mr. W. H. Preece, F.R.S., Mr. E. C. Robins, Sir Owen Roberts, Lord Sudeley, Lord Thurlow; with Mr. H. Trueman Wood (secretary), and Mr. H. B. Wheatley (assistant-secretary).

The Council will proceed to consider the

award of the Albert Medal for 1888 early in May next. The medal has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.. "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michael Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture, have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific

traveller, and a Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communication of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Mr. Samuel Cunliffe Lister, "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 6, 1888; Colonel A. C. HAMILTON, R.E., in the chair.

The paper read was—

THE SOUTH AFRICAN GOLDFIELDS.

By W. HENRY PENNING, F.G.S.
(Late of H.M. Geological Survey of England.)

In a paper which I had the honour of submitting to the Society, and which was read on April 29, 1884—now nearly four years ago—I ventured to predict that the auriferous region of the Transvaal would be found, as it has been found, to cover nearly all the northern and eastern districts of that State. I confess that at the time I did not anticipate its extension to the western border also, which has, however, since proved to be the case. But it may be safely asserted now that the whole of the Transvaal is gold-bearing, except the "High Veldt" in the centre. It is not by any means impossible or improbable that even this district may yet prove rich in gold, a metal which, in Africa, occurs in unexpected places, and under entirely novel conditions.

The gold region thus amplified must naturally extend far beyond the arbitrary boundaries of the State, and under similar conditions, but I must remark here that my own observations have been almost entirely confined to the Transvaal—that is to say, in connection with gold. I take that, however, to be the typical auriferous district of South Africa, presenting, as it does, the peculiarities of all, and under the best conditions for examination.

It should be understood that my present object is not by any means to dilate upon the special value of these goldfields in general, which already asserts itself by actual production. I would certainly avoid any demonstration of the particular richness of any mine or property, and even the relative values of different districts, judged as they must yet be from incomplete data; although I may cite certain facts which testify to the confidence reposed in their future prosperity. I would rather discuss the general questions of the extent of the gold-fields, the character and extension of the auriferous deposits, the general nature of the ores and of the gold, in connection with the requisite machinery and available power for their manipulation.

The Transvaal consists of two distinct regions eminently diverse in general character, their line of separation being well defined. These are the elevated plateau and the low country. The former has a general altitude of about 5,000 feet, but gradually slopes away westward, and has isolated peaks rising up to more than 7,000 feet above the sea, and it occupies, in general terms, the central, the western, and the southern portions of the State. The latter is at a general level some 2,000 feet lower, gradually sloping away eastward towards the sea, but presenting also subsidiary ranges of mountains. This region covers the eastern and northern portions of the Transvaal. The dividing line is the precipitous eastern face of the Drakensberg Mountains, which towards the north becomes more broken up, and passes with less abruptness down to the level of the lower area.

As the physical features of the two areas vary, so also, to a great extent, do the geological, the line of division between them being the eastern edge of a great series of high-lying horizontal deposits that do not therefore extend over the older, totally distinct, and greatly broken up formation of the low countries. This is a brief and very general indication of the main physical and geological

characters of the Transvaal, continuous, as to the plateau, in the Orange Free State, and as to the low country, in Natal; features which will be described in somewhat greater detail in connection with the different goldfields.

Until recently there has been a strange and persistent absence of belief, especially in this country, in the mineral wealth of the Transvaal, and it must be remembered that, similarly, at the time of the first discoveries of diamonds in Griqualand, now a part of the Cape Colony, their occurrence was for some time considered a mere fabrication. Long before, on the other hand, at the first mention of gold in California and Australia, people flocked there in thousands, but, for some unexplained reason, it has taken several years to raise any but the most superficial interest in the gold of South Africa. Some time after the earlier announcements, a party of Australian diggers certainly went over to see for themselves, but most of them gave up all hope of success, and left the fields declaring that there was no gold in the country.

This disbelief, which is now rapidly passing away, although none too rapidly, was to some extent excusable on the part of "practical diggers," who had been accustomed to seeing reef-gold in quartz fissure veins only, and could not, at any rate did not, anticipate the occurrence of the metal in any other kind of permanent deposit. Even they might, however, have drawn the conclusion that gold having undoubtedly been found in alluvial wash, its former home must be somewhere in the immediate vicinity, whether as fissure-veins or otherwise. But there are those who, admitted to be authorities on the subject of gold, have declared that no permanent auriferous deposits would be found—at Pilgrim's Rest and Spitzkop for instances—yet we are constantly hearing of the opening up of fresh "reefs," as they are called, yielding from a few pennyweights up to several ounces of gold to the ton. One brief official extract from a recent announcement on this point may suffice: —

THE TRANSVAAL GOLD EXPLORATION AND LAND COMPANY.

The following telegram, dated January 30, has been received :—"We have struck a reef of ore 2 ft. wide, and prospecting 7 dwt., near Ophir Hill." The manager's written advices to January 3 have also been received, and are as follows: "Brown's Hill Mill—During the week the mill was at work (5 heads only) for 100 hours on Columbia Hill ore, and crushed 83 tons. The clean-up of plates yielded 142 ozs. of amalgam, showing the value of the ore to be over 10 dwt. per ton. Peach Tree Creek—The weight of ore extracted here last week was 15 tons, averaging 1 oz. 8 dwt. per ton assay value. Jubilee Hill—During week we have extracted at 812,100 tons, assay value 1 oz. 14 dwt. per ton."

It is true that gold occurs under entirely novel conditions in each of the main auriferous tracts of the Transvaal, and equally so in other parts of South Africa. I have already said that the whole of the Transvaal (with a possible exception of its central High Veldt) is now known to be gold-bearing; still, it can be conveniently divided into three distinct areas, both physically and geologically, and in each of the three we find the metal under peculiar circumstances. I directed attention to this in a paper read before the Geological Society, early in 1885, and published in the quarterly journal for November, in regard to two of those areas—Lydenburg and De Kaap, and I shall do so now in regard to the third, viz., the new gold-field on the Witwatersrand.

The Kaap Valley goldfields are situated upon and around the margin of the low country, the rocks of which are schists and shales, with interstratified beds of quartz-rock and quartzite, which are often highly auriferous. The rocks having been tilted from a horizontal into a nearly vertical position, these gold-bearing beds simulate true fissure-veins, but it is beyond question that they are stratified deposits; therefore, auriferous beds, such as were not known before (so far as I am aware), although "flat bands of auriferous quartz have been discovered in dykes of diorite" (Phillips), which, however, being in diorite, are veins, and not beds at all.

The Lydenburg goldfields are upon the plateau, where the rocks are horizontal shales, sandstones, and cherts, with inter-bedded seams of auriferous quartz, and crystalline conglomerate, and exhibiting here and there the peculiar sandy deposits, often very rich in fine gold, locally known as "rotten-reefs."

In both of the goldfields there are occasional true fissure-veins and stringers of auriferous quartz, but these form the rather rare exceptions to the general rule.

The Witwatersrand goldfields are upon the western edge of the High Veldt plateau, where we find a series of rocks that present some decided and important differences from those of both the other goldfields. These are chiefly soft sandstones, with some shales, cherts, and quartzites, like those of the High Veldt proper,

but tilted, as are the rocks of the low country, into a nearly vertical position.

At intervals between the sandstones and other beds, there are interstratified layers of conglomerate, which vary in thickness from a few inches up to several feet—always following the same line of strike as the beds in which they occur, and having the same dip or inclination. These conglomerates are of all degrees of coarseness, from a large-grained sandstone with occasional pebbles of small size up to a regular "pudding-stone" with pebbles as large as hens' eggs, or even of greater size. They vary also in compactness and colour, some being soft, others hard, some white, others grey, purple or brown, the enclosed pebbles being equally variable from white quartz to black hornstone. From its peculiar appearance, the Dutch have given this conglomerate the name of "Banket" (pronounced bahn*kett*), or almond-rock, which is very expressive, and may be conveniently retained, as it is in general use on the Fields. This rock is auriferous, sometimes highly so, and in very few instances, in this particular region, is it quite bare of gold.

There is a striking similarity in the present position of the auriferous seams of the Kaap Valley and the Witwatersrand, both being broken through and tilted up by a central mass of granite, but the resemblance extends no further. It may be worth while to briefly describe this feature as indicating where further discoveries are certain to be made, and I may quote the words used by me in the paper to which reference has already been given:—

"An intrusive plutonic rock, geologically newer than the stratified rocks, but still in an inferior position, occupies the whole of the lower ground of the western part of the Kaap Valley. It resembles coarse granite, and consists of quartz and felspar, with but little, if indeed any, mica in its composition. Although this granite (for such it may be called) forms generally the lower ground of the head of the valley, it rises into hills and ridges, some of which have a considerable elevation. In the Kaap Valley the surface of the granite forms an ellipse about seventeen miles in length by ten miles in width, with a narrower prolongation in a northerly direction. This mass of granite represents a great centre of plutonic upheaval, of course posterior to the period of the Kaap Valley rocks, which it has greatly tilted all round its margin; it was, however, anterior to the deposition of the rocks of the overlying unconformable formation, as they are still nearly horizontal. Nearly all around the granite centre is a series of rocks which have been tilted by it into a more or less vertical position."

In the case of the Witwatersrand the granite, which is of precisely the same character, occupies the ground from the foot of the steep northern escarpment overlooking the headwaters of the Limpopo which traverse the lower area between it and Pretoria. The width of the granite is about twenty-five miles on a northerly line from the Witwatersrand, the stratified rocks coming on again about six miles south of that town, which is thirty-three miles or so from Johannesburg.

The rocks of the Rand are chiefly sandstones, sometimes micaceous, with occasional shales, cherts, and quartzites, especially towards the base of the formation which abuts against the mass of granite already mentioned. The intrusion of this granite has tilted the rocks to a high angle near its northern margin, where they are almost vertical; further south they gradually assume a less inclination, and eventually are seen in a nearly horizontal position. In illustration of this, the observed dips of the reefs may be recorded along three parallel lines, from E. to W., at the distances of about one mile, two miles, and three miles respectively, from the face of the northern escarpment.

	Degrees.
No. 1 line (1 mile S. of escarpment)—	
N. end of Knight's Mijnpacht (Driefontein)	80
Near the town of Johannesburg ..	85
Crown Company (Whitehead's) ..	80
Roodepoort	70
No. 2 line (2 miles)—	
Vogelsfontein	40
S. end of Knight's Mijnpacht....	40—50
Elandsfontein (centre)	45
S. of Johnannesburg	40
Langlaagte	45
Paardekraal....................	35
Vogelstruisfontein	40—50
No. 3 line (3 miles)—	
Modderfontein	30
Elandsfontein, S. end..........	20—30
Ras' Farm (De Pass Company) ..	19

A similar mass of granite occurs at and near the village of Klerksdorp, about twenty-five miles west of Potchefstroom, appearing to follow the valley in a north-westerly direction towards the Maqwassie Mountains; it has also tilted up the stratified beds, and exposed on both sides of the Schoen-Spruit the outcrop of "bankets" similar to those of the Rand. At the time of my last visit, in July of the past year, this new field was beginning to attract attention.

In all these cases the dip of the stratified rocks is away from the central granite, and their outcrop follows its margin in more or less parallel lines, except where intercepted by intrusive dykes of later date, or broken by faults, some of which, on a rather large scale, occur in parts of the Kaap Valley.

The practical question naturally arises whether these auriferous seams possess any great lateral and vertical extension. The former can be readily proved, but the latter is not so easy of demonstration, although, in my opinion, the one virtually hinges on the other. To take the bankets as an illustration, there is no *a priori* reason why these gravels should have originally extended further in an east and west than in a north and south direction. If it were so, it would have been highly improbable, almost impossible, that the upheaval by the granite should have exposed their present edges exactly along what was, on this presumption, an attenuated line of deposition. Such line would surely have been tortuous, not straight, and the outcrop of the conglomerates at the present surface would in consequence have been intermittent. But with very few exceptions it is decidedly continuous, and it may therefore be fairly argued that the bankets originally extended, and still extend, as far in the one direction as in the other. That is to say, if they can be traced, as they undoubtedly can be, for 30 or 40 miles, with a practically unbroken outcrop, from east to west, there is no valid reason why they should not have extended 30 or 40 miles from north to south. If so—and the present exposed edge represents a medial, or what may be called an average line—they pass beneath the surface of the ground for half that distance, not vertically to any great depth, for I have shown that the strata only where near to the granite are almost vertical, and that they have a gradually lessening dip, which, in the course of three or four miles, must bring them back into their original horizontal position.

These reefs can be traced on the surface for 30 miles at least, and the fact is too well known to require confirmation; it may, however, be mentioned that the tracing of the so-called Main Reef was such an easy matter to prospectors, that its apparently sudden ending near the western boundary of the farm "Driefontein" was a source of surprise—not to say of consternation. It was, however, lost there, and considerable sums of money have been forthcoming for its re-discovery—no very difficult matter, as its disappearance at or about that point is due to its being "thrown" by a "fault," and not to its actual termination.

Again, the so-called Kimberley, Sunday, and Free State reefs are known from end to end of the Rand; this group being distinguishable, not only by its position relative to the Main Reef, but by its own well-defined characteristics. And all the reefs, in whatever group, maintain a fairly consistent width or thickness, varying somewhat, but to no great extent, and (of course, with some few exceptions) not "pinching out" entirely, or their outcrop would fail to be, as stated above, unbroken for 30 miles. There are some few instances in which these reefs really die out, both laterally and vertically, as must of necessity be the case in deposits that were once horizontal, and whose extent was bounded by ever-varying conditions. But these lines of limitation would have been so far apart, that the chance of the occurrence of more than one such line (*i.e.*, of the pinching out of more than one reef) is reduced to a minimum, within the breadth and depth of even an extensive series of mining operations. If occasionally a reef should be found to thin entirely away at a depth, there is an exactly equal probability of another coming in that had not been exposed at the surface, as is evident from a consideration of their mode of origin.

This argument in favour of the downward extension of the gold-bearing bankets applies with even greater force to the Kaap Valley auriferous deposits, the outcrop of which extends more than halfway round a nearly circular mass of granite, than to the bankets which follow a line curved only about 3 miles from the straight in its known length of 30 or 40 miles. It bears also upon the still horizontal quartz seams of the Lydenburg goldfields, the outcrops of which may be greatly obscured, but some have been traced intermittently for considerable distances, and along tortuous contours, which fact points to the conclusion of their extending over large areas.

Another point of great practical importance is the origin of the gold in these peculiar deposits; referring not so much to the source whence it was actually derived as to the mode by which it was conveyed. I am aware that this is approaching debateable ground, but, as much depends thereon, I would offer a few remarks which may perhaps assist in solving the question whether we may expect to find an equal or a partial distribution—in other words,

whether the reefs will be found "patchy," or their yield fairly persistent.

It will be convenient to again take the bankets as presenting the clearest evidence, for whatever might be said of the vertical quartz-rocks, there can be no question that these conglomerates, full of water-worn pebbles, are alluvial deposits. But the gold they enclose is sharp reef gold—not water-worn as nuggets are supposed to be, but as I believe very few are—therefore not alluvial; neither has it been (except in some instances to be again referred to) formed into nuggets by some secondary process of aggregation.

It is, perhaps, not easy to conceive by what agency masses of gravel can have been accumulated that are several miles in length and probably of equal width—such gravel being of fairly uniform thickness throughout, although in some cases with considerable variation. The conditions of deposit were intermittent, for we find numerous layers of conglomerate, some only a few inches, and many several feet thick, with uniform beds of sandstone between. Sometimes a little talcose shale intervenes, but this appears to have been in very limited areas, as it soon thins out in each direction. There are also some calcareous deposits, sufficiently persistent to be supposed to mark an horizon; for instance, they are found in connection with the "Kimberley" series of conglomerates. But the rock generally associated with the gravels is sandstone, varying in coarseness and hardness, with foliated schistose rocks below them, then cherts and quartzites at the base of the formation which abuts against the granite. By whatever agency the gravels may have been accumulated over such large areas, we have ample evidence of their existence in the upturned edges of the bankets of the Witwatersrand, at least as regards their length of many miles, and that they possess great breath also is, as I have endeavoured to show, a reasonable conclusion.

If the gold were alluvial, brought into the gravels in the same manner as the pebbles must have been—by the action of running water, it would certainly be found in "leads," and probably the larger portion of it accompanying the heavier pebbles. But thus far it appears to be equally distributed, for each banket, although it may differ in auriferous value from those above and below, maintains an equable richness for long distances. The conglomerate, as we have seen, was spread with remarkable regularity over a large area, and we are justified in concluding that, as in so many points within that area the conglomerate is rich in gold, so it will be in the intervening portions, because there is no evident reason why the agencies of gold distribution should not have been equally uniform. It is contended that, in the absence of any evidence to the contrary, it is right to assume that the banket is no less rich in the intervals between those points; that, in short, the opened ground is a fair indication of that which is undeveloped. Looking to the sharp form of the grains of this gold, to its freedom from the coating so often found on that which is really alluvial, and to the equality of its distribution, I am convinced that this was deposited—at the same time that the gravels were being accumulated—from water holding gold in solution.

It seems to me that this is the only way in which to account for the presence of gold over such large areas as these must have been, with so little variation in its distribution. There is variation vertically, the term being, of course, applied to the deposits in their original position, consequent on the varying rapidity of the formation of gravel and of the deposition of gold. In this way, not only would one banket differ from another in its proportion of gold, but its own component layers would exhibit unequal degrees of richness. This is generally the case, indeed I have seen some which are very rich in coarse gold on the one side, and contain but a mere fractional part of fine gold on the other. This variation is also noticeable in some of the quartzose rocks of the Kaap Valley, especially one in regard to which I remarked, in the paper alluded to above:—"One side of the quartz seam called Moodie's Reef, which would be its north wall if a true vein, but is what was originally its underside as a bed, is plentifully sprinkled with specks of gold, rather fine, but still visible to the naked eye. There is gold also in the body of the quartz, but, so far as I have been able to ascertain, only in small quantity." Whether or not my view be correct as to the origin of the gold in these stratified deposits, I venture to believe that the evidence adduced, founded mainly on my own personal observations, justifies the statement that not only in two of the three distinct auriferous regions of the Transvaal, but in all of them, the gold exhibits decidedly novel modes of occurrence.

If this be so, if the gold be actually in beds—and I have myself no doubt whatever upon

the point—is it not a feature of immense importance to South Africa and the world at large? We have here not mere fissure-veins which may rapidly disappear, but stratified deposits (enclosing the auriferous layers) of enormous area which have hitherto been merely scratched upon their outcrop—for what are a few hundred feet when miles are in question? Not useless miles straight down, as might appear from some of those exposures where the beds are seen at the vertical part of the curve made by the granite in breaking through them, but miles of deposits gradually flattening outwards from the centre of upheaval. Those nearest to the granite may soon get below a workable depth, but not so with those that form the outer concentric rings of outcrop around the granite. As we have seen, in the Witwatersrand at any rate, these outer beds dip away at an angle of only a few degrees; so that in these, and in the horizontal seams of the Lydenburg Fields, the quantity of available auriferous ore, hidden though it be under newer deposits, is practically unlimited, and certainly beyond estimation.

It may be mentioned here that, although the auriferous banket somewhat resembles the "cement-stone" found in many parts of the world, it is not by any means the same thing. There are two kinds of deposit known by that name, through their being consolidated or cemented together by a matrix of ferruginous sand; one is old auriferous gravel, well known in Australia, California, and South America; but the gold it encloses is water-worn and strictly alluvial. The other is rather common in South Africa, and is merely an old deposit of surface-wash, which is auriferous where the conditions are favourable. It has formed generally on large flats, and it rests indiscriminately on the solid rock or on true river gravels, as at the town of Lydenburg in the Transvaal. There is gold in the neighbouring hills, and it is found in alluvial form both in the river gravel and the overlying cement-stone, but in both having a very unequal distribution.

The general nature of the ores of each district may now be briefly considered, as presenting several practical and important questions in regard to milling machinery. It will have been observed that in every area the auriferous stone differs somewhat from that of the others; each kind requiring, therefore, a somewhat different mode of mining, and of treatment in milling. The rich quartzose and quartzite seams of the Kaap Valley are compact and hard, in nearly vertical reefs, varying from a few inches up to several feet in width, and sometimes enclosing sulphides of several metals.

The quartz of the plateau is of softer nature, and with fewer sulphurets; it is sometimes very rich, but occurs frequently in seams too thin for profitable mining. The crystalline conglomerate is of moderate hardness, and carries coarse gold; the rotten reefs are very soft, earthy, and somewhat greasy—containing gold that is so fine as to escape the ordinary processes of amalgamation.

The fissure-vein quartz in the Kaap Valley and the plateau is of the ordinary nature, but is small in quantity compared with other deposits—it would be mined by shafts, levels, and stoping in the usual manner.

The Witwatersrand "bankets" vary greatly in hardness as regards the matrix of the enclosed pebbles, and in thickness from a few inches up to several feet. The pebbles, which are not usually auriferous, range from the size of a pea to that of the fist, and are thoroughly rounded by water action. Some of the intervening deposits, ordinary sandstones, are decidedly auriferous, especially in their lower portion, where they enclose a few small pebbles.

The varieties in the character of the ore—some being hard, others soft, some refractory, others amenable—and in the condition of the gold—some being free, some coated—call for the use of different kinds of machinery. It is usual to speak of "stamps" in connection with gold-mining, whereas in many cases their use is a great waste of power and money, other apparatus being far cheaper and more effective. And the problem still remains unsolved how to treat in large quantity, and so as to save the bulk of their gold, ores which from various causes cannot be satisfactorily dealt with by the ordinary processes of amalgamation. This is a point upon which I speak with diffidence, but to which I would direct special notice, and in regard to it express the hope that ere long some of those able men who are giving their attention to the subject may be rewarded by complete success. For some mechanical method, or process, or method and process combined, whereby the gold can be brought into actual contact, so as to amalgamate with mercury, would make all the difference, in many notable instances, between present failure and future great success.

The gold in some of the seams in the Kaap

Valley is fairly free, and in others is associated with many sulphides; but in the Lydenburg Fields (and perhaps to a small extent in the others also) two conditions prevail most unfavourable to the saving of the gold. One is antagonistic to the use of known mechanical means; the other to either chemical or mechanical, on account of the difficulty both of bringing it in contact with mercury, and of securing it otherwise by concentration for after treatment. Those conditions are, first, the presence in some of the deposits of pyrites (sometimes arsenical), and of a small quantity of carbonaceous matter, probably as a shale oil, either of which rapidly "flours" the mercury, and so renders it inoperative. This has been the great cause of failure in some well-known instances, three-fourths, or more, of the gold having gone to waste in the "tailings," notwithstanding every precaution. Secondly, the extreme fineness of the particles of gold, which are so minute that they actually float on the surface of the water employed, and will continue so to float—as powdered sulphur would—for an indefinite period. These particles will sink to the bottom when once wetted, but therein lies the difficulty; it can be done, in a gold-washing dish for example, but not readily. To effect this, the powdered ore must be thoroughly mixed with water in the dish, and, after settling a few seconds, some clean water allowed to flow slowly over the surface. A second mixing or shaking, and some more clean water, will have wetted the fine gold, so that the ore can now be panned off in the ordinary manner, the gold will then show like a thin streak of paint in the dish. The method is simple enough as regards panning, and can be acquired by a little practice; a "prospect" of fine gold being obtained which would most certainly have gone out of the dish at the first plunge in the absence of these precautions. The gold of the Witwatersrand is mostly "free," and of various degrees of coarseness; it is, however, fine in some instances, but generally presents no other difficulty of manipulation.

There are numerous ingenious contrivances for keeping mercury "alive"—where it would otherwise "sicken" and "flour"—by the use of sodium-amalgam and by the application of electricity, the former being an old plan and by no means infallible. The latter is now on its trial, and will, I believe, eventually be found successful in the treatment of South African ores. The chief difficulty seems to be in passing any large quantity of pulp through some of the machines—otherwise excellent—that have been designed for the purpose of ensuring contact between the gold and clean mercury. For this reason I am inclined to prefer a plan recently brought to my notice, which consists of passing a current of electricity through the mercury on the silvered plates of an ordinary table, over which as large a quantity of ore may pass as usual. But the difficulty still remains of getting the fine gold *down* on a large scale, although it can be done in a dish; it must be at the bottom of the water, or it will not come in contact with the mercury, however shallow the stream. A simple plan of my own for catching "float-gold" whilst actually on the surface of the water may perhaps succeed in doing so, but I refrain from more than this passing mention until full trial shall have been made, not here, but where fine gold in perfection can be met with—in the older Lydenburg gold-fields.

Speaking of course in general terms, and having regard to the varieties of the ore and of the conditions of the gold, I advocate the use of the following appliances in the different districts:—

Kaap Valley.—Heavy gravitation stamps, silvered plates, and Frue vanners for concentration of the sulphides, for future treatment by the Newbery-Vautin or some allied process.

Lydenburg.—Stone-breakers and pulverizing mills (except for the rotten reefs), silvered plates, and Frue vanners. The rotten reefs should be treated by passing the ore through crushing or rolling mills, and by some special apparatus and treatment for saving their fine gold.

Witwatersrand.—Pulverizing mills, especially after the ore has been exposed to the action of the weather, ordinary tables and blanketting.

Although general characteristics largely prevail throughout each district, no strict line can be drawn, defining the limits of refractory or amenable ores, coarse or fine, free or coated gold; in many cases both occur in the same mine, as they do near the Devil's Kantoor, and on the Blyde river. Each limited area, each property, in fact, must be finally judged on its own merits, and determination made of what methods, what processes, and what machinery, are best adapted to its characteristics.

Another very important point in connection with the extraction of the gold, is the presence or absence of available water-power, and, fail-

ing this, the cost of fuel necessary for driving the machinery. Now, reverting for a moment to broad physical features, we see that the low country is intersected by several rivers, and that the eastern edge of the plateau is on the main watershed of the country; so also is the Witwatersrand. It will be readily understood that, other things being equal, those rivers which flow east to the Indian Ocean must possess far greater power than those which fall westward from the same height in six or seven times the distance into the Atlantic. But two of the districts with which we have more immediately to do, are on the watershed; one of them, however, being partially traversed, also, by the eastern streams, and therefore holding an intermediate position.

Therefore, the Kaap Valley, being traversed by the eastern rivers, possesses, generally, the greatest available water-power (except on the summit of its ranges), which may be applied with great advantage to the propulsion of machinery.

The Lydenburg Fields have not much power at command, except here and there where intersected (transversely to their normal westerly streams) by the head-waters of the easterly flowing rivers. In this district, therefore, water, or steam, or both can be used for supplying motive-power, according to local circumstances.

Wood is very scarce, and reliance must be placed therefore on obtaining a supply of coal.

The Witwatersrand has very little water capable of supplying power, except at a few miles distance from the mines; this district must, therefore, depend mainly upon steam for driving its machinery.

The High Veldt is the great high level coalfield of South Africa, as I have shown in a paper read before the Geological Society on March 5th, and published in the quarterly journal for November, 1884; the coal seams of which, being horizontal, coincide with the boundaries of the upper portion of the great plateau. Coal occurs at a much lower level in Natal, on the east side of the Drakensberg; also in the vicinity of the Lebombo mountains.

At any rate for some time to come, all supplies of native coal to the goldfields will have to be derived from some part of the high level coalfield, whether in Natal or the Transvaal. Its nearest point, where at all opened up, I consider to be where the following note was taken by myself and given, amongst others, in the paper to which reference has been made:—

"In some shafts sunk upon two farms near the edge of the (upper) plateau, by the road from Middelburg to the Komati, at about 5,000 feet elevation, the following sections are exposed:—

"No. 1.	No. 2.	
ft. in.	ft. in.	
7 0	10 0	Loose ground.
0 10	2 0	Inferior or fine coal.
1 6	1 6	Black shale.
2 3	+ 2 3	Coal of good quality (not bottomed in shaft No. 2)."

The inferior coal would doubtless improve in quality at a short distance from the outcrop.

This edge of the coalfield is about 45 miles from Barberton, which may be considered the centre of the Kaap Valley goldfields—about 35 miles from those on the Komati—40 or 45 miles from the Devil's Kantoor, and, generally, 60 miles (as the crow flies) from the Lydenburg goldfields.

The western edge of this coalfield, beyond Heidelberg, approaches to within about 32 miles of Johannesberg, the centre of the Witwatersrand goldfields. At this nearest point, on the Zuikerboschrand River, there is a seam of excellent coal, 5 ft. to 6 ft. thick (with others below) horizontal, and at a general depth of about 20 ft. below the surface, beneath a roof of hard sandstone.

Therefore all the goldfields thus far referred to have good coal available within a reasonable distance, the cost of which at the mills will probably be found to vary from 30s. to 70s. per ton, allowing for road-transport, but will be much less when tramways or railroads shall have come into operation.

Last year there was quite a commotion on the Rand when it was asserted that at last some rich alluvial deposits had been discovered—this was at a spot a few miles west of Johannesburg—and very soon hundreds of claims were pegged out in that locality. A quantity of "nuggetty gold was being found, but there were no alluvial deposits in the sense that was understood; they were such, but the gold within them was certainly not "water-worn." The site of the discovery was along, or rather just below, the outcrop of one or more of these banket conglomerates, where the stone was of an unusually soft description and greatly decomposed. Whilst the bulk of the banket had been washed away, the gold had sunk down *in situ*, and had afterwards been formed into nuggets of various sizes, even up to some ounces in weight, by the ordinary process of aggregation. The physical features of the locality were, of course, favour-

able to this; the bankets dip S., and a small stream, flowing also S., had excavated a shallow valley transverse to the outcrop, which is E. and W. The gold shed from a crumbling reef so situated would sink down into pockets on the N. side, that is behind the outcrop, which would prevent its being carried away by water trending in a southerly direction. The gold thus found in considerable quantities was not in the bottom of the valley, but on the gentle slope of the hill, and even then not in a terrace-gravel, but in pockets along a line of decomposed banket as already indicated.

The explanation offered is the correct one, in my opinion, and is corroborated by the form of the gold, which in bulk, at first sight, looked very like alluvial, but not on closer inspection. It consisted of discoloured particles and nuggets, more or less rounded as though water-worn, but many of them presented deep cavities, in which true reef-structure was still distinctly visible. In one instance a nugget the size of a nut consisted merely of a quartz pebble, around which a thin coating of gold had been deposited; a valuable specimen—that I was, however, unable to secure—as it offered conclusive evidence of the mode of origin of the so-called alluvial gold.

The formation of many parts of the country is favourable to the collection of such deposits of gold away from streams, and I am certain that the exercise of the method known as "pocketting" would be rewarded by the discovery of them in great numbers. Gold, except when very fine in grain, does not travel far, and once on the bed of a stream, its greater specific gravity soon takes it down, through sand or mud, on to the bed-rock, there to be caught in fissures, behind transverse "bars," and innumerable small projections. I find it impossible to believe that all the gold, or even more than a fractional part, that was once enclosed in the enormous masses of reef that have been wasted and worn away by natural agencies in South Africa, can have been transported either to the Atlantic or the Indian Ocean.

Let us take which area we will—the Kaap, Lydenburg, or Witwatersrand—the same or similar features present themselves for consideration—incalculable quantities of auriferous rock removed and passed through the natural sluice-boxes of the streams and rivers. The Kaap Valley is a large fan-like depression 1,500 to 2,000 feet lower than the hills around its margin, all its waters passing through the Kaap Poort (which is the handle of the fan), 40 miles in length, to join the Krokodil River. What has become of the enormous mass of rock, enclosing gold veins, which at one time filled the valley, 20 miles long and 12 miles broad, up to the level of the hills around? It has all been swept, during untold ages, through the Kaap Poort, and it is simply impossible that no alluvial gold deposits are left in the valley beyond the isolated patches discovered at Jamestown and elsewhere. I say that these patches are not merely the exception to the generally accepted rule of there being no alluvial goldfields in South Africa, but that they are indications merely of future discoveries of greater importance.

Again, the Lydenburg goldfields are traversed by the Blyde River, that has carved out a valley 2,000 feet deep in hard siliceous rocks with auriferous quartz seams and "rotten reefs" between. Does the rich creek of Pilgrim's Rest, a mere tributary, contain the only remnant of the alluvial gold of that region? And is there no alluvial gold at all upon and in the country around the Witwatersrand? Certainly none of any consequence has hitherto been discovered there, but it is there all the same, for a vast expanse of rocks enclosing the rich bankets has been swept away—certainly half a mile or more in thickness—over the whole surface of the granite between the Rand and Pretoria.

In considering this question, we must not fail to notice that the interior of South Africa, at least its central plateau, has been dry land for a very long period. There are no traces of the tertiary deposits which fringe the coast at a very much lower level, and, as I have mentioned elsewhere, streams which fall into the Indian Ocean on the east, take their rise on the west side of the Drakensberg mountains, having had time to cut back stupendous gorges through the range. During all this long continental period, the land has been subjected to the agencies of the last sub-aërial denudation, and the forces of those agencies, probably, were much more intense formerly than now; or rather, perhaps, their results were of a different character. I need not enter more fully into this question, and would merely suggest that the intensity of those forces as excavating agents is long past its maximum. The valleys are now cut down to so low a level, that the tendency is for them to be filled up rather than otherwise by detritus washe down from the hills, the streams having cu back their courses so far, that many of th watersheds are reduced to the narrowest limt possible.

In illustration of this suggestion I may mention the fact that three important rivers take their rise, not as mere streamlets, but fair-sized rivers, within one farm—the Blyde flowing N., the Speckboom W., and the Sabic E. There is a still more remarkable case, in which tributaries of the Sabic and Krokodil rivers have cut back their channels, in opposite directions, to a wall-like termination, with now barely room for a waggon-road between, on either side of which the gorges are several hundred feet deep, and exactly opposite each other in four or five places, thus giving rise to the peculiar mountain-pass known as the Devil's Knuckles.

In excavating these deep valleys the streams must have run at numerous levels, all traces of their earliest courses having long since been swept away, but those of intermediate date, are marked by river-gravels on the tops and sides of the mountains. In the paper to which reference has already been made, I stated that, "in many instances the terrace-gravels, which are relics of an earlier stage of denudation, are also gold-bearing. In Willey's Creek and at Pilgrim's Rest Creek are high terraces of rich alluvial wash. I have also observed patches of river-gravel at least 800 feet above the present Speckboom River." And as I remarked in my "Guide to the Goldfields," published in 1883, "payable alluvial fields will be discovered, not exactly along the courses of the existing streams (although fine gold may be found here and there in such situations), but at a greater distance from them, on the hills and terraces where alluvial deposits now represent the lines of an ancient denudation."

In some cases every particle of gravel may have been washed away, which would otherwise have represented high-lying remnants of the old river-beds, but a great deal of the gold will still have been left behind. Although it is probable that further north about and beyond the Limpopo, the more usual condition of things may prevail, I venture to assert that in such more or less elevated situations will be found the rich alluvial deposits that must exist somewhere or other in this region, and so add one more to the surprises of South Africa.

These deposits, whether of auriferous gravel or mere pockets, will certainly be very old, but there are others more ancient, which will yet be proved to contain payable alluvial gold—deposits in one sense equivalent to, but still dating much further back than the "deep leads" of Australia. I will not enlarge upon the evidence in favour of the existence of such deposits, but I think it will be readily admitted and that they should prove, at no distant date, to be of very great value and importance. We have but to refer for a moment to the geology of the high-level plateau, where the rocks repose upon the upturned edges of those of the low country, and to note their relative position; can it be otherwise than that the gold from the waste of those sharply truncated rocks below should have remained in the upper deposits formed directly from their denudation? Such gold would not be equally distributed, as in the conglomerates of the Witwatersrand, but being alluvial, in the true meaning of the word, would accumulate in "pockets" and in "leads" or channels. We have evidence of this in the water-worn gold embedded in the old crystalline conglomerate which occurs, in two or more layers, amongst the sandstones of the Devil's Kantoor. I have seen many nuggets, one weighing over 12 ounces, taken from this very formation there, and in other parts of the Godwaan plateau.

In the Witwatersrand we have conditions that must have led to the deposition of comparatively modern, but still not recent, auriferous alluvium. Up to a certain point in time, the streams here, as elsewhere, cut deep and narrow gorges through transverse belts of compact rock that by-and-bye resisted further excavation. Then the gorges and valleys above them began to be filled up with detritus, that must contain gold from the disintegrated bankets; at first, probably, as coarse gravel, then sand, until at last they became large alluvial flats, and treacherous swampy marshes, of which there are many, on and about the Rand. There are many recent swamps filling recent hollows, in which only traces of gold would be found; but where the earlier conditions prevailed, as briefly indicated, there, in my opinion, rich alluvial deposits await discovery. Many of these must still occupy old gorges and valleys, now buried, but not without leaving traces of their former existence; it may be at a depth which would be a serious obstacle to the individual digger, but with the appliances now available, the point raised is one well worthy of combined practical investigation.

The remarks that I have made apply almost exclusively to the Transvaal, but gold has been found, and is still being found, far beyond the limits of the State. My notes were taken chiefly in its central and eastern

districts, but the Waterberg and the Zoutpansberg in the northern area, although not yet as well known, will probably prove to be equally valuable. We have seen that the auriferous bankets are found at Klerksdorp, and these will doubtless extend still further west, not only to the new fields of Malmani, but even to Bechuanaland. In a southerly direction, the gold - mining concessions granted by the king 'Mbondine, in Swaziland, are on a continuation of the same geological formation as the Kaap, as probably are also the new goldfields of Natal and Zululand. I have no doubt that in all directions, except south-west, the same conditions will be found to prevail—of very old auriferous stratified deposits, here and there turned up so that their broken edges are now exposed around intrusive masses of granitic rock. This feature should guide us to future discoveries, the exposure at the surface of a large mass of granite being much more easily detected than the outcrop of narrow auriferous beds (amongst many others that are barren), especially in a country so much covered by sand as South Africa. For once a bed is proved gold-bearing in any locality, its relation to the boundary of the intrusive rock affords a ready means of detection, elsewhere, of the outcrop of the same bed, or of others, at about the same horizon.

This novel state of things, whether in regard to the auriferous stratified rocks, or to the alluvial gold in areas that have long been dry land, is not necessarily limited to South Africa. Gold having once been proved to exist there in quantities remunerative to the miner, in such deposits and under such conditions as I have endeavoured to briefly describe, it will be sought for—and probably found—under similar circumstances elsewhere. I am satisfied that deposits which hitherto have been considered mere country-rock, and localities believed to be barren, will yet be proved auriferous, and that a knowledge of the facts brought to light in South Africa will contribute largely to the welfare of other parts of the world.

DISCUSSION.

Mr. F. A. Robinson asked whether electric power had been transmitted from a distance to work the batteries of which Mr. Penning had spoken. He said that in the Witwatersrand district water was often found in large quantities, but at a distance of two or three] miles from the mines, and he should like to know whether any attempt had been made to transmit the power by means of electricity.

Mr. Topley desired to offer his acknowledgments to Mr. Penning for his very able and lucid account of the goldfields in the Transvaal. He referred especially to his description of the Witwatersrand goldfield, which was quite a new point, of which geologists knew practically nothing. There had been no description published hitherto which would account for the presence of gold, and he had been very much interested in what had been said as to the mode in which it occurred there. The author spoke of a succession of beds of conglomerate, reaching through great thicknesses of strata; and the idea which some people had of their being in some way veins or lodes, but of a peculiar kind, arose from their being occasionally pitched at high angles. It had always been a puzzle to anyone who had seen the specimens how anything of that kind could be in the nature of a lode. On the other hand, it had struck him that if they were at all in the nature of gullies, full of alluvial deposits, they could not be expected to go very far. Mr. Penning had described how the gravel was an old stratified deposit, but the gold was not alluvial, and he, having not only seen these small specimens, but having gone on the ground, and visited a large number of openings, was better qualified to speak than anyone else. It was interesting to find the gold described as having been deposited from solution in water around pebbles in the conglomerate. He presumed this meant that after the conglomerate had been deposited, the water percolated through, and deposited the gold, and he should like to know how this was to be accounted for. There was an idea that gold was to a certain extent soluble in water, and that nuggets grew in alluvial deposits, but Mr. Penning said he did not believe in that. Possibly the deposition might be due to some such action, as was supposed to have deposited the gold in the form of the Mount Morgan deposits—from water at a very high temperature. These gold-bearing beds of sandstone, being actual beds of sandstone formation—not narrow gullies, rather led to the belief that they went a considerable distance, and would yield a large amount. Another point of special interest was the idea that there were in South Africa large deposits of alluvial gold. It must have struck anyone who had studied the geology of the country, how extraordinary it was that, so far from the sea, where, as they knew, for long ages the rocks had been wasted by sub-aerial action, they could not discover where the gold had gone to. They knew that it had not been swept away by torrential or marine action, because it was clear that the country had all been dry land for a very long time; but they did not seem to have found the alluvial deposits, such as had yielded such enormous quantities of gold in Australia and California. If, as Mr. Penning thought, there were modern alluvial deposits yet to be found, the future of South Africa was indeed a strange one; and it might rival in some degree the great output of

gold from Australia and California. It was well known that the great influxes of gold had always come from such deposits, whilst a steady output on which they should look most thankfully came from quartz veins. He could hardly congratulate South Africa if there was a likelihood of her being subjected to one of those gold rushes which so greatly demoralised a country. Mr. Penning had referred to those who were sceptical, some time ago, as to gold resources of South Africa, and possibly he was included amongst them, as he prepared a paper last year for the British Association, on the distribution of gold throughout the world, in which he spoke of South Africa as not likely to rival Australia or California in this respect; but at the same time he expressly said that many paying companies would be formed; but what he did not look for, and was hardly prepared to believe even yet, was that gold would be found in sufficient quantity to tell very largely on the general supply of the world. The total product was about twenty millions annually, and to have any appreciable effect on that, which was the point then under discussion at the British Association, the output must be far in excess of anything they could expect at present from South Africa.

Mr. Penning, in reply, said he was not aware that electric power had been applied in the Transvaal goldfields, but there was no reason why it should not, as in many instances there was quite sufficient waterpower in the rivers to be used that way; and where the rivers and streams were at a distance from the goldfields that would be a good way of utilising that power. The question of how gold had formed round and amongst the pebbles came under the general heading of the origin of the gold. The occurrence of gold in those deposits was certainly peculiar, and demanded a special explanation. He admitted there were difficulties, but maintained that the presence of sharp reef gold in these alluvial beds must have resulted from precipitation. It must be remembered that the deposits themselves were peculiar, at least the bankets and rotten reefs, formed, as he believed, at the bottom of an inland sea, were deposited from water holding silica in solution. In this they had further analogy to auriferous fissure veins in which quartz and gold were deposited simultaneously, in the one case in vertical gradually-opening fissures, in the other as a sediment at the bottom of the sea. It appeared to him that the thin chalcedolite, with earthy partings between, must have been so formed. The water may have been much warmer then than now, which would increase its dissolving power, but subject to the recurrence of cold periods or seasons, which would result in precipitation, and so also would a change either in the chemical or electrical condition; but this was a problem for specialists to decide. With regard to the alluvial gold, he failed to see where all the gold had gone out of the reefs and bankets over all these square miles of ground, and hundreds and thousands of feet in depth. He did not believe it could have travelled down the rivers to the sea, and if it had not it must and would be found some day in the neighbourhood of the reefs from which it had been derived. He was quite certain in his own mind that along the lines of the old rivers, some of which were 800 or 1,000 feet above the level of the present rivers, there would yet be found payable, and very likely rich alluvial fields. In conclusion, he would say that the South African goldfields had had a rapid growth, especially of late, when properties, which at one time were thought valueless, were again coming to the front, particularly some on the Blyde River. The object had not been to give a history of the fields, which were rapidly verifying his former prediction as to their value, and he had carefully abstained from touching on the political question of the Transvaal, which would probably settle itself ere long in consequence of a very large influx of mining population.

The Chairman then proposed a hearty vote of thanks to Mr. Penning for his very interesting paper. The question of the deposit of gold in these conglomerate beds was one of extreme interest.

The vote of thanks was carried unanimously, and the meeting adjourned.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 7th, 1888; Edward C. Robins, F.S.A., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Tucker, John, Talbot-house, Rickmansworth.

Walker, Samuel, 22, Moorgate-street, E.C.

Yeates, A. G., More-hall, 85, Tulse-hill, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Chapman, A. G., Pierrepoint-lodge, Springfield-park, Acton, W.

Debenham, Frank, 26, Upper Hamilton-terrace, N.W.

Forsyth, Rev. James Shepherd, M.A., 33, Stock Orchard-crescent, Holloway. N.

Jones, H. Macnaughton, M.D., F.R.C.S.I. and Edin., 141, Harley-street, W.

May, Gustav Adolphus. 2, White Hart-street, Paternoster-square, E.C.

Parker, George, 3, Ambleside-avenue, Streatham, S.W.
Sykes, Benjamin Clifford, M.D., M.R.C.S., St. John's-house, Checkheaton, Yorks.
Whitaker, William, 4, Marine-terrace, Whitehaven.
Winstone, Ernest H., 2, Victoria-mansions, Victoria-street, S.W.

The paper read was—

FRAMEWORK KNITTING.

By W. T. Rowlett.

The object of the present paper is, in the interests of technical education, to give some idea of the intricacies of the manufacture and the great need of a special technical training for those engaged in this pursuit.

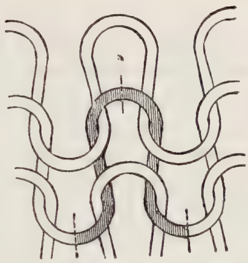
The time at my disposal this evening being limited, I shall only allude briefly to the history of the stocking-frame, devoting my efforts more particularly to the explanations of the various machines and processes of the framework-knitting industry.

As you no doubt are aware, the stocking-frame was invented in the time of Queen Elizabeth, by a poor clergyman, named William Lee, at Calverton, near Nottingham. The story relates that he sat brooding over his misfortunes, and watching his wife knit, with the baby on her knee; as he noticed her make a stocking, stitch by stitch, the idea of a machine which should do the work much more rapidly was being gradually formed in his mind. This machine I shall have the honour of describing to you later on.

After completing his machine, he applied for a patent; the Queen, however, refused, saying that the manufacture of stockings for the people was too important an industry to be placed in the power of one man, but that if he could so improve his machine as to make silk stockings, she would then grant him a patent. Lee returned home and perfected his machine so as to produce the silk stockings, but the patent being still denied to him, he took his machine to France, and there established the manufacture under the protection of King Henry IV.; but after the murder of the King, being a Protestant, he was neglected, fell into want, and died in Paris in 1610. His brother, James Lee, took several frames back to England, and there he established the industry. The manufacture was continued in France by the workpeople left behind, principally Protestants, till the revocation of the Edict of Nantes, when a number of them fled into Germany, taking some frames with them, and by the end of the 17th century, framework knitting was spread over Hesse, Wurtemburg, Bavaria, Thuringia, and Saxony. This latter country is, at the present time, the strongest competitor that England has in the manufacture of hosiery.

The special property of knitted fabrics, rendering them so well adapted for articles of clothing which fit close to the body, is their elasticity. Unlike woven fabrics, which are composed of longitudinal and transverse threads, and are non-elastic, knitted fabrics proper are made with one thread only, from which horizontal rows of loops are formed, each row hanging in the loops of the preceding one (Fig. 1). This it is which gives

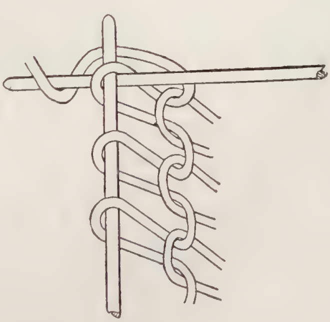
Fig. 1.



the fabric its elasticity, owing to the thread being bended backward and forward continuously in opposite directions.

Figs. 2 and 3 represent a piece of hand knitting, of which you perceive the whole row of

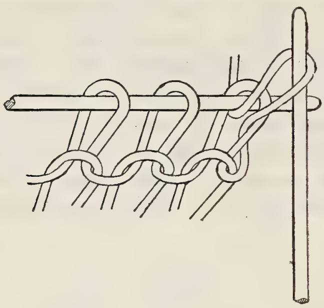
Fig. 2.



stitches are upon the one needle. To make a new row the end of an empty needle is inserted into the first stitch and a piece of thread pulled

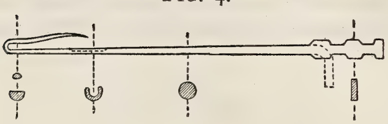
through, whilst at the same time the old stitch is cast off the first needle, thus leaving the first stitch of a new row upon the second needle. This is continued stitch by stitch until the whole row is knitted off the first needle, and the new row is completed on the second one.

FIG. 3.



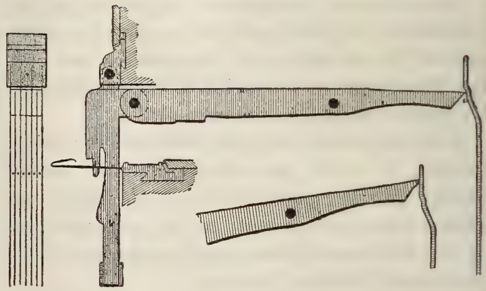
Instead of forming each stitch separately, Lee's idea was to form a whole row at once. To effect this he made a row of hooked or bearded needles (Fig. 4), corresponding in number to the stitches in one row, or course, as it is technically called. The hook or beard of this needle, you will observe, is long and elastic, and in the shank of the needle, just under the point of the beard, is a groove or eye so that when the point is pressed down it closes the hook, and allows any loop which was upon the shank to be pushed over it. The loops

FIG. 4.



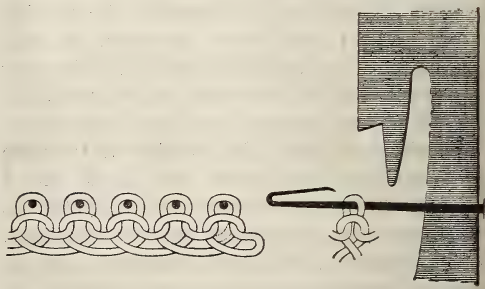
are formed by a row of instruments, one to every needle, each having an independent action (Fig. 5). These are called sinkers, and hang perpendicularly between the needles. They are jointed loosely into the ends of a set of horizontal levers called jacks. These jacks turn on a wire, which runs through the whole row, rather behind the middle of their length, and at the hinder end press against a spring with a curve in it, so that when the hinder ends of the jacks are depressed they fit in the curves, and are held in that position until released. Of course, as the part of the jack forward is the heavier, and has also the weight of the sinker upon it, the moment the hinder end is released the sinker falls. The distance through which they fall is regulated by a horizontal bar under the fore part of the sinkers, which is called the falling bar. In order to keep the jacks the proper distance apart, they are laid between the teeth of a brass comb, and the wire upon which they turn is passed through holes in them and the teeth of the comb, so as to form a succession of hinges. This comb is called the jack bar, and upon the truth and firmness of it depends

FIG. 6. FIG. 5.



the value of the frame, as this is the foundation of the frame. There is yet another important instrument required, namely, the presser, which is a straight, knife-like bar, reaching across the whole row of needles, so as at the proper moment to press down the points of the needle beards into the eyes, and thus allow the stitches to be pushed over them.

FIG. 7.

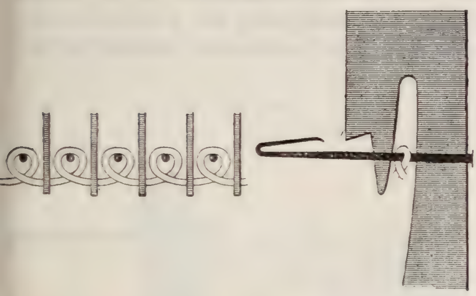


I shall now proceed to describe the manner in which these various parts are arranged, and their working.

First, the needles are cast in pairs, in a mixture of tin and lead, technically known as leads; these leads are secured on a horizontal bar, called the needle-bar, by plates screwed over them. The needles must al be

of the same size, thickness, and shape, and the same distance apart as their own thickness. This needle-bar is the front part of the square framework which supports the whole frame. At the ends of the needle-bar the two sides of the framing are carried downwards, and formed into hinges, into which are jointed two arms, reaching upwards, and carrying the presser.

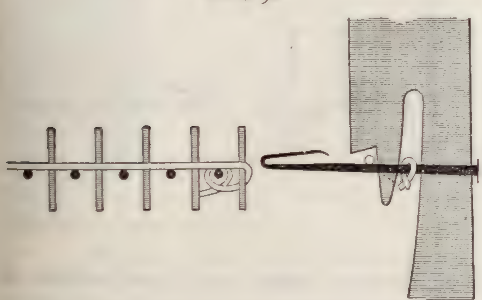
Fig. 8.



At the hinder part of the framing stand two pillars, which are joined by a cross-bar, and jointed at their upper extremities, so as to carry an axle, from which two horizontal arms reach forward, having two vertical rods at the other end, called the hanging cheeks. These two hanging cheeks are again connected by cross-bars.

The jack bar and springs are fixed upon a little carriage on wheels, running upon the side-bars of the framing; the sinkers hang at

Fig. 9.

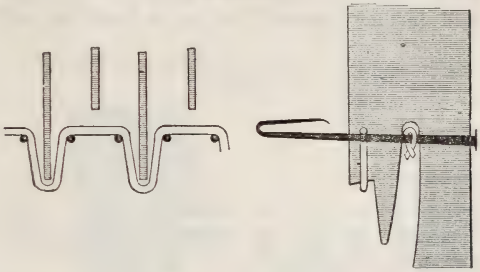


the forward end of the jacks, between the needles, and are held together at their lower ends by the cross-bar at the bottom of the hanging cheeks, and a plate screwed in front of it.

In order to actuate the sinkers, a little carriage (Figs. 16 and 17), with a wedge-shaped projection in the centre, is drawn under the hinder ends of the jacks, so as to raise them one by one, and thus depress the opposite ends, which carry the sinkers. The various motions are given to the frame, partly by the hands and partly by the feet of the workman, who sits on a seat in front, forming part of the wooden stand which supports the frame.

You will observe the peculiar shape of the sinker. The forward portion, called the nib (Fig. 5) is for laying the thread; the slit

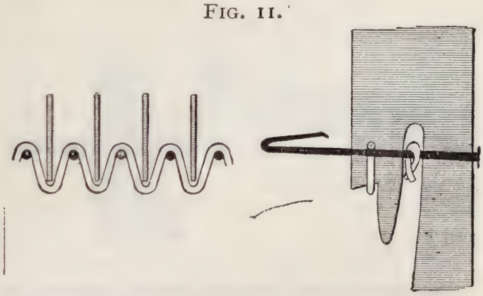
Fig. 10.



behind, called the throat, is for taking the finished row of stitches to the back of the needles; and their lower projection on the stem, called the belly, is for pushing the old stitches over the heads of the needles, so as to draw the new stitches through them.

In commencing to work, it will be more intelligible to you if we suppose a row of stitches to be already upon the needles. The sinkers are brought forward and pressed down, so as to enclose the stitches in their throats, and then taken to the back of the needles. The

Fig. 11.

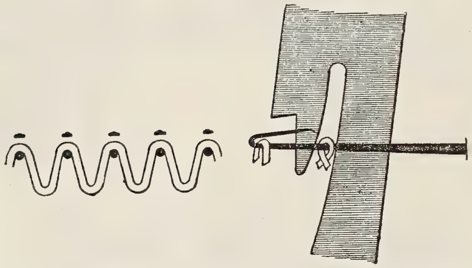


drawings will show the various motions, so that you can more readily understand them.

Fig. 5 shows a side view of the needle and sinker without any work or thread upon them. Fig. 6 is a front view. Fig. 7, a front and side view of a course of stitches on the needles. Fig. 8, a front and side view of the row after the sinkers have been raised, brought forward, lowered and taken back again, so as to enclose

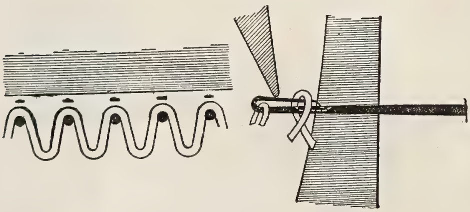
the stitches in their throats, and take them to the back of the needles. Fig. 9 shows front and side views of the needles, with the thread laid across them, and under the nibs of the sinkers. Fig. 11 shows the new loops sunk between the needles. Fig. 12, the new loops pushed under the needle beards, the sinker raised and brought forward, so as to bring the old stitches close to the points of the beards. Fig. 13, the beard held down by the presser, so as to bend the point into the eye and close the hook, whilst the sinkers are raised and brought still further forward, so as to land the old

FIG. 12.



stitches upon the beards. Fig. 14, the presser raised out of the way, and the forward motion of the sinkers continued, thus completely knocking the old row of stitches over the ends of the needles, and, at one operation, pulling the whole row of new stitches through the old ones, leaving the throats of the sinkers ready to fall down, enclose the course, and bring it back to the position shown at Fig. 8.

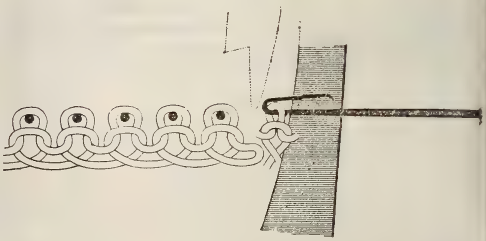
FIG. 13.



The stitches which are made round the needles are called the needle loops, and the portions of thread which lie ronnd the sinkers, and connect the course of stitches together, are called sinker loops. It will be well to bear this distinction in mind, as I shall have to refer to it later on.

You will observe that in these motions there is a sinker attached to a jack, for every needle. These are actuated by the little carriage before mentioned (Fig. 16) which is called the slurcock, being drawn under the tail of the jacks, so as to release them one by one (Fig. 17). This plan answers very well for coarse work, but as it necessitates a jack for every needle, it becomes impracticable for very fine work; in practice, therefore, there is generally only a jack and an independent sinker to every other needle, so that the loops are laid as shown in Fig. 11, and not as in Fig. 10. In order to distribute these loops evenly over every needle, there is another set of sinkers hanging alternately with the jack sinkers (so called from being connected with the jacks).

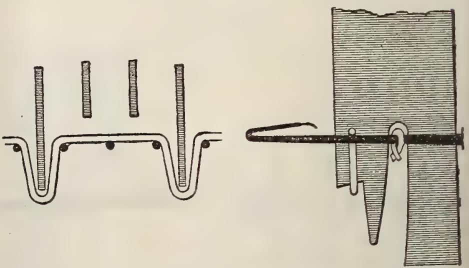
FIG. 14.



These are called lead sinkers, from their being cast in leads at their upper ends like the needles, and are screwed on to the upper bar connecting the hanging cheeks, which is called the sinker bar.

After the loops have been sunk between every other needle (Fig. 10), the lead sinkers are

FIG. 15.



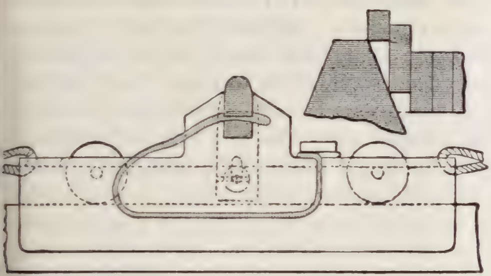
brought down bodily upon those portions of the thread stretched across over two needles, and at the same time the jack sinkers are all raised, so as to bring the nibs of both sets into a horizontal line, and thus an even row of loops is formed between all the needles (Fig. 11). This last operation not only has the advantage of enabling much finer work to be made, but it renders the machine less liable to make stitches of unequal length, as any inequalities in the laying of the loops are rendered less perceptible by their subsequent division.

In the very finest frames, there are two lead sinkers to every jack sinker, so that each loop has to be divided into three. (Fig. 15.)

The needles are usually cast two in a lead, and the gauge of the frame is indicated by the number of these leads in three inches. Thus a 30-gauge frame has 30 leads or 60 needles in 3 inches = 20 needles per inch, and as the distance between the needles is equal to the thickness of each needle, it follows that must be 1-40th of an inch.

In order to produce good work, the edges of the nibs and bellies of the sinkers must all be exactly at the same level, also the shanks and heads of the needles. This will give you some idea of the delicacy of adjustment necessary in a stocking-frame.

FIG. 16. FIG. 17.

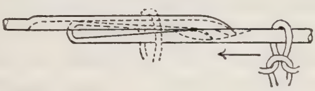


I have been thus particular in describing the original stocking-frame, because if I have succeeded in making you comprehend its working, you will have less difficulty in understanding any other machine I have to explain, as the main principles of Lee's frame are, more or less, carried out in them all. I regret that there is not more time at my disposal to explain the various ingenious motions so well adapted for their particular ends in Lee's stocking-frame. It is perfectly marvellous that, with the limited mechanical knowledge of Queen Elizabeth's time, he should have invented a machine so nearly perfect, and which, even in my lifetime, was with very little alteration, the principal machine used in the manufacture of hosiery.

The process I have described would, if continued, produce a piece of knitted web of equal width all down. This when sewn up would form a stocking leg, but without any proper shaping to fit the ankle. In order to fit the leg, or, in the case of a shirt, the arm, it is necessary the article should be fashioned. There are two ways of doing this without cutting the web; one is by shifting the stitches inward from each edge, so as to narrow the fabric; these are called "narrowings." The other by shifting the stitches outward, so as to widen the fabric; these are called "widenings," pronounced "widdenings."

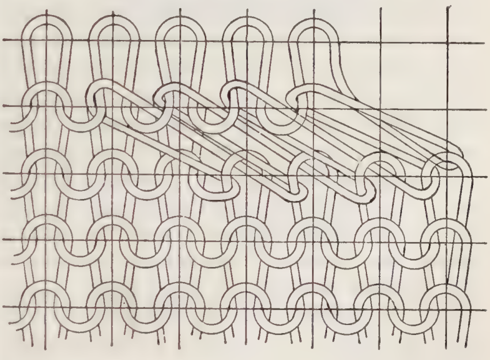
To do this a further set of instruments, called "points" or "coverers," is employed (Fig 18). As many of these points are used as there are stitches to be shifted. The number is usually four or six. These points are grooved in their under surface, and so formed as to cover the

FIG. 18.



beards of the needles and fit into the needle-eye. Thus, when the sinkers are brought forward, the stitches are pushed off the needles on to the points, which are then moved inwards the distance of two needles, when the stitches are re-transferred to the needles, leaving the two outer ones empty, and the fifth and sixth needles each with two stitches on (Fig. 19). This is repeated at the other edge

FIG. 19.



of the web, which is thus narrowed by four stitches.

In widening, the same instruments are used, but instead of shifting the stitches inward, they are carried outward so as to make the fabric wider. As this makes a hole in the fabric by leaving empty needles, widening is only done by one needle instead of two at a time, and therefore requires to be performed twice as often as narrowings. There are various methods of closing the hole left in the work, but the most perfect one is that of catching the stitch which was made by the empty needle in the previous course, and placing t

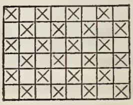
upon that needle, so that every one then has a stitch upon it, and the course is complete.

Up to the present I have only described the mode of producing the plain hosiery fabric, but an endless variety of stitches is made upon the stocking-frame. Of these, the most important one, next to the plain work, is the ribbed fabric, which is made by pulling certain stitches of the same course, through in opposite directions. The one most generally used is called the "one and one rib," having alternate stitches pulled through in opposite directions. This fabric is extensively used for making elastic tops for the ends of socks, drawers, and undershirt sleeves; and in many cases entire articles are made of it. The machine for producing it was invented by Jedediah Strutt, of Derby, in 1755, and consists of a second set of needles upon a movable bar, which hangs in arms under the frame needles, so that the rib machine needles project upwards between them, and in front of the work. When the stitches are taken to the back of the needles before commencing a new course, the machine needles are taken back with them, and the course is made in the usual manner, but when the sinkers are brought forward to knock over the work (Fig. 14), the machine needles are brought forward at the same time, so that when the stitches have been knocked over the heads of the frame needles, the sinker loops lie round the shanks of the machine needles, which are then drawn down so as to enclose these loops under their beards. The beards are pressed to close the hooks, and the downward motion being continued, the old stitches are landed on the beards and pushed over the needle heads, thus drawing the stitches through in the opposite direction to those in the frame needles. This fabric is still more elastic than ordinary framework knitting, as the alternate stitches, being pulled through in opposite directions, have a tendency to draw closer together, and when pulled apart to spring back to their original position.

There are many kinds of ribbed fabrics in which the number of stitches in the ribs vary, such as 2 and 1, 2 and 2, 6 and 2, &c., the first number indicating the number of needles together in the frame, and the second the number in the machine. Some of these are very difficult to produce, and would take too much time to explain upon the present occasion.

For making fancy hosiery, such as shawls, mitts, children's gaiters, &c., a number of supplementary apparatus are used. The first of these is the "Tuck presser." You will remember the knife-like bar which presses the needle beards, to close the hooks in forming the stitch (Fig. 13). The edge of this bar is cut, so as not to press upon certain needles, whereby the stitches are knocked over some needles, whilst both the old and new stitches are left upon others, and by varying this, patterns are produced. For example, suppose the course of stitches upon the needles to be black, and the presser to be cut so as to press the odd needles only—Nos. 1, 3, 5, 7, &c., and the new course of stitches to be made of a white thread. The black stitches would be knocked over the heads of those needles which had been pressed, and in their place would hang single white stitches of the new course, whilst the needles of the even numbers—2, 4, 6, 8, &c.—would have two stitches each, a black and a white one. Supposing the next course to be made of a black thread, and the presser moved sideways, so as to press those needles only which were missed in the previous course, they would have the two stitches knocked over, leaving a black stitch hanging in their place, whilst the needles 1, 3, 5, 7, &c., would have two stitches on. Shift the presser back to its original position, and lay a white thread again for the next course, and keep repeating these operations, laying alternately a white thread and a black thread for each course, and the result will be—not horizontal, but downward stripes of colour, as the white stitches only are shown from the odd-numbered needles, and the black ones from the even-numbered ones (Fig. 20).

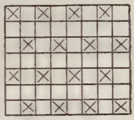
Fig. 20.



This is the simplest form of what are called "Tuck patterns," and I think you will easily understand that by varying needles which are tucked, as the non-pressing is called, various figures may be produced. I will only instance one simple variation to illustrate my meaning. Take a white thread, and make one course of plain work in which every needle is pressed, then make a black course, pressing the odd needles only, followed by a white course in which every needle is again pressed. After that a black course in which the even-numbered

needles are pressed. This being repeated will produce a white ground with black spots upon it (Fig. 21). The next apparatus in most

FIG. 21.



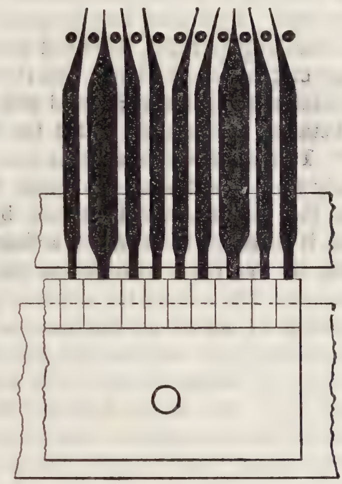
general use is the "Top" machine, which is composed of points or coverers like those used in making the narrowings (Fig. 18). These points are arranged in any desired order on a bar opposite to and on a line with the frame needles, so as to take certain stitches off the the needles, and transfer them to other needles, thus producing patterns in the work, with or without varying the colour.

Another somewhat similar machine, the "Knotted Stitch" machine, works with a number of points which enter some of the titches as they hang from the needles, and stretching them sideways, pass them on to the next needle, so that one needle has only half a stitch on, whilst the next one has one and a half. This makes a fabric covered with little elevations, which at one time was very fashionable for ladies' stockings.

Another very important machine is called the "Pelerine;" and, before the invention of the lace machine, it was extensively used for making point net lace. This consists of a number of points on a bar, like that which carries the needles of a rib machine (Fig. 22). These points project up between the frame needles, and when the course of stitches is knocked over, they are brought forward into the sinker loops. They are then raised up, turned horizontally, lifted above the needles, and moved sideways, so as to lay the sinker loops over the needles, thus altering the character of the work. For some patterns several of these points are bent, so as to draw the loops aside when they are raised up; sometimes two points are bent, so as to unite at the upper end, and when raised, to stretch the sinker loop, and cast it over two or more needles. Of course, this machine is only used with very loose work, as if the fabric were made tight it would break the stitches instead of stretching them only.

Although the stocking-frame marvellously increased the speed of production, the original machine, which only made one article at a time, is now out of date, and quite unsuited to the requirements of present ideas as to speed. About forty years ago, a commencement was made to build frames to make more than one at once, adding guides to lay the thread across the needles, and a machine to shift the stitches. This machine is similar to the top machine, but only has points for the edges of each division of the frame, so as to take off the stitches from both sides of all the articles simultaneously, and transfer them inwards, thus narrowing all the articles at one operation. Some of these frames were built so wide as to make seven stockings at once, and required a powerful and skilful workman to manage them. As they came more extensively into use, the wages earned by the workers in frames producing only one article

FIG. 22.



at once, and which could be very well managed by a lad or a young woman, were, of course, much reduced; still, some able-bodied men continued to work them, with the natural result of getting miserably paid, either from laziness or natural incapacity to work the more modern machines.

Efforts were, and are still, continually made to further increase the speed of production, and one of the results was the perfection of the circular frame, which produces a tube of work, and in which, the various motions for making the stitch being continous, and all at work simultaneously, the amount made is greater than by any other frame, even up to the most recent inventions.

The first circular frame on record was patented by a Frenchman named Decroix, in

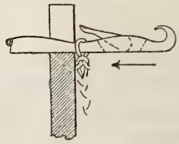
1798, and was followed up by Aubert of Lyons, in 1803, and Leroy of Paris, in 1808, who constructed one with wheels to lay the loops. Sir I. Brunel also patented one in 1816, which is the model upon which French and German circular frames are built, and for making large pieces of cloth is still held in high estimation. But the first circular frame for making tubes narrow enough for a stocking leg was built by Messrs. Paget and White, of Loughborough, some time before the year 1845. It consisted of a number of bearded needles placed perpendicularly round a tube, and having an independent up and down motion; the thread being laid between them by a number of horizontal sinkers. This machine produces very good work, and was for a long time used only by this firm.

The most popular circular frame, however, was that invented by Moses Mellor, of Nottingham, in 1848. This also has perpendicular needles standing parallel, but fixed upon the revolving circular needle-bar. The thread is laid between the needles by a wheel with teeth fitting between the needles, called the "loop wheel." This wheel works upon an axle fixed separately from the frame, the teeth fitting between the needles, and is turned by the frame as it revolves, the needles acting upon the teeth in the same manner as two cog wheels work. The axle of the wheel is placed at an angle of about 45 degrees, so that as it revolves it not only carries the thread in the form of loops between the needles, but also under the needle beard. This is followed by another similar one, called the "dividing wheel," which again presses upon the loops to ensure their evenness, and carries them under the needle beards right up to the heads. Next comes, inside the circle, the "landing wheel"—which pushes up the old stitches from the bottom of the needles, far enough to land them on the beards, which are pressed into the eyes just at the proper time by a plain presser wheel on the outside of the frame. The stitch is completed by another inside wheel—the "knocking over wheel"—which pushes the old stitches off the needle beards right over the heads of the hooks. A curved piece of iron, inclined downwards inside the circle, takes the work down to the bottom, ready for the next course.

When these frames are made of large diameter they have several sets of wheels, each working a separate thread, so that at each revolution a number of courses are made. Both the French and English systems of circular frames are extensively employed for the Jersey cloth now so much in use, and the adoption of which has caused the introduction of this class of machinery into the cloth manufacturing districts of Yorkshire.

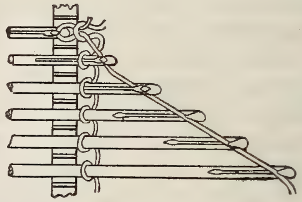
About 1858, Mathew Townsend, a hosiery manufacturer of Leicester, invented the self-acting or latch needle (Fig. 23). The object

FIG. 23.



of this was to do away with the presser, which was accomplished by making the hook of the needle short and without a beard, whilst further down the shank was hinged a little spoon-like lever, (Figs. 23 and 24), which, when turned over so that the bowl of the spoon lay on the end of the hook, shut it so as to enclose the new loop, and allow the old stitch to slide over it (Fig. 24).

FIG. 24.



This needle was neglected for many years, but being introduced into the circular frame, it speedily came into very great favour, as by simply moving backwards and forwards, the needle was able to perform all the operations of knitting without the aid of any other instruments, and thus it became possible to make a great number of courses at once upon a frame narrow enough for a stocking leg. Sixteen is not an uncommon number, so that by arranging the sequence of colours fancy stripes in great variety are obtained.

We often hear the stocking loom spoken of, but this is an erroneous title, as a loom is essentially a machine which works from a warp, or set of longitudinal threads, whereas a stocking frame works with one or more transverse threads only.

Amongst the variations of the stocking-frame, there is, however, a machine known as

a warp-loom, which has needles, sinkers, and presser, like a stocking-frame, but all the sinkers are lead sinkers, and all come down together instead of successively, as this machine has a thread to every needle, which passes through a guide, one to each needle, whose function is to lay the loops. As a whole course of loops are laid by one operation, the working of this machine is very rapid. The fabric produced in many respects resembles the ordinary hosiery fabric, but all the threads lie perpendicularly instead of horizontally. I have said that the warp-loom has a thread to every needle, but this is true only of its original form. In its development it sometimes has one thread to two or more needles, and sometimes several threads to each needle.

The variety of fabrics produced is very large, some being close and others open. A great proportion of the knitted shawls, so much worn, are made upon it, and the cloth for the white Berlin gloves worn by men-servants; whilst it is extensively used in the lace-trade for making window-curtains, imitation crochet-work, &c. The principle of the warp-loom is especially adapted for working by power, and nearly all are now worked in this manner.

Time forbids me to do more than just glance at this important class of machines, and I must turn now to power, or rotary frames, as they are called. These machines work automatically, and at first were simply a reproduction of the motions of the hand-frame, actuated by levers and cams.

The first practical rotary frame was Moses Mellor's, of Nottingham, which was brought out about 1849, and copied the motion of the hand-frame. Its great advantage was that it could be made so much wider, and thus produce more pieces of work at once. Its disadvantage was that it only made pieces of work the same width all down. Eventually, a top machine, worked by hand, was introduced, so as to narrow the work, and ultimately the top machine was arranged to work automatically. This machine very much resembles a large hand-frame, and, to a casual observer, notwithstanding all its improvements, still looks very much the same. Its most recent adaptation has been to produce ribbed work, in which form it is still in great demand.

Another class of rotary frames which has been extensively used, and particularly in France and Germany, is Paget's, invented about 1855 by Mr. Arthur Paget, of Loughborough. The principle of laying the loops differs from the ordinary frame, the sinkers being independent of any jacks, and each one making a separate loop, without any subsequent dividing, whilst the needles all draw back together, to bring the loops under the beards, and to knock them over. But several important modifications in the manner of laying the thread across the needles, and the self-acting narrowing machine, were introduced into this frame, and form the basis of many similar improvements in other systems. It works with scarcely any noise; a decided advantage. This may be considered to have been the first self-acting frame.

This frame was originally built to make one article only, and a worker minded a row of them, but Mr. Paget has recently added several other great improvements, and has commenced to build them in several divisions, so as to produce a number of articles at once. This bids fair to become a very valuable machine.

The frame most in favour of late years is Cotton's, of Loughborough. This, like Paget's frame, is also almost noiseless. Instead of the needles being horizontal, they are perpendicular, and the sinkers are horizontal. The work comes horizontally, and the needle-bar, carrying the needles, moves down and up to knock over the work, &c. Unlike Paget's frame, there are two sets of sinkers, one working with jacks in succession, the others without jacks and altogether. It has also a self-acting narrowing machine, and from the lightness of its movements, can be constructed very wide. In some instances these machines make sixteen stockings at once. This frame has done more than any other to cheapen the production of fashioned hosiery, but some are of opinion that the newest Paget's frame may prove a formidable rival to it.

Both the frames last described have been adapted to produce ribbed work, but that on Paget's principle is almost unknown in this country, although it is largely used in France.

By most of these machines articles are produced in separate parts, and joined together, either by sewing or by setting portions of them on to the frame needles and then working other portions on to them. It will suffice if I describe how a stocking is made. First the leg is worked, then the heel; originally on two separate frames. In the most recent frames, the web is divided when the heel is reached, and three separate threads used, so as to make the two sides of the heel, and the instep.

When the heel is made sufficiently long, the two side pieces are pressed off the needles, and the centre piece only continued, so as to form the upper part of the foot; this is narrowed for the point of the toe, and when finished, pressed off the needles. The sole of the foot is then made on a separate frame, either by first setting the sides of the two heel pieces upon the needles, and then working it to them, or else separately, and joined by a seaming machine. The seams to complete the stocking are either sewn by hand or by machine.

The circular stocking, which is the cheapest form of all, is made from the tube alone. A piece of web sufficiently long for a pair of stockings is first cut off, and then in the middle of its length divided into half tubes long enough to form the feet (Fig. 25). A slit is cut in the part where the half tube begins, and the latter then turned round, its end sewn into the slit so as to join it to the heel (Figs. 26 and 27), the sides being afterwards sewn up to complete the foot, and the raw edge at the knee turned over inwards and sewn to form a kind of hem. This stocking looks very shapeless until it has been drawn upon a wooden form, and pressed between two heated iron beds, after which it has the appearance of a properly fashioned stocking (Fig. 28).

FIG. 25.

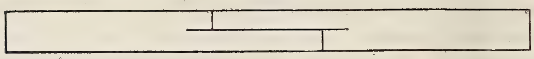


FIG. 26.

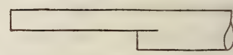


FIG. 27.

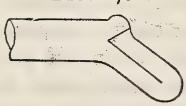
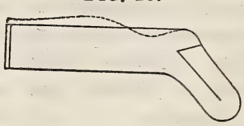


FIG. 28.



I shall not attempt to describe the various processes of dressing and finishing hosiery, as this paper is already quite long enough, but will conclude by a reference to the knitting-machines which are coming extensively into use. These machines all owe their existence to Townsend's self-acting or latch needle, by means of which, as I have already said, all the necessary motions for forming the stitches can be performed without any other instruments being necessary. They are of two kinds, the straight or Lamb machine, so called after its original inventor; and the circular machine.

The "Lamb" machine consists of two sets of needles crossing each other at an angle, like those in a rib machine. These needles are raised by the cams on a straight bar, and lowered, one by one, as a thread s carried across them, so that the hooks catch it and form it into loops, whilst the old stitches close the latches of the needles as they slide down, and then fall on their heads, thus slipping over the new stitches, and completing the loop (Fig. 24). When both sets of needles are worked together they produce ribbed work, but when first one set and then the other are worked they form a tube, or two flat pieces of web joined at the sides. This work can be narrowed by shifting the stitches at one or both edges, and complete articles of hosiery may be made without taking the web from the needles; but all such operations are performed by hand.

The circular knitting machine is sometimes made with one set of needles only, to produce plain work; but it is generally made with two sets, one perpendicular and the other horizontal, radiating from the inside between the perpendicular ones, so as to produce ribbed fabrics. As they are worked by hand, the needles are shifted from one set to the other; or needles thrown out of action in one set, and the stitches shifted on to fresh needles brought into action in the other, so that the kind of work produced is varied. For example, in making a sock, first a 1 and 1 rib-top is made with alternate needles in each set, then the stitches are transferred, so as to leave them alternately 3 in one set and 1 in the other, which produces a 3 and 1 rib for the sock-leg; after which all the odd needles are taken from one-half the circumference, and the stitches transferred to the corresponding half-circle of the other set, thus making a tube half plain, and half 3 and 1 rib. The heel is formed out of the plain work, by moving the frame to and fro, and making stitches on certain needles only; then the whole is revolved, forming a plain sole and ribbed instep for the foot; and lastly, a backward and forward motion of the plain portion makes the toe; so that when the article comes off the machine, it only requires joining at the toe to be complete.

These machines are suitable for making very useful articles, but do not produce work sufficiently good nor fine enough for high-class hosiery.

I trust that my explanations have been sufficiently clear to give you some idea of the enormous scope of the framework-knitting industry, and the great need those engaged in it have for a technical education. The greatest competitor Great Britain has is Germany, where technical instruction has been given in this branch for many years. Classes have been formed, with a certain amount of success, in Leicester and Nottingham. It is hoped they may ultimately become as successful as those in Germany. Unfortunately, although the subject of technical instruction is at the present time attracting a great deal of notice; manufacturers, and the general public, are very slow to perceive the necessity of it. I trust that the present paper may have some small share in awakening them to a sense of its great importance.

DISCUSSION.

Mr. GOODALL (Nottingham) said he was very glad to have had the opportunity of hearing the paper, but he did not think he could add anything to it. He wished, however, to say how much the English hosiery trade was indebted to Mr. Rowlett for the valuable translation he had made of Professor Willkomm's work, which was now generally accepted as the text-book with regard to hosiery. The translation of that book from the German, carried out in an admirable manner, had been of great service to the hosiery trade; and he desired, on behalf of the Nottingham manufacturers, to express their indebtedness to Mr. Rowlett for it. It would have been noted that one great point with regard to the hosiery manufacture was the elasticity of the fabric, and although there had been great improvements within the last twenty years, in the matter of speed, and consequently in the cheapness of the articles made, he might say that there had been hardly any improvement in the intrinsic quality of the article from the first. It was a matter for wonder that William Lee, the inventor of the frame knitting-machine, should have been able, three centuries ago, to produce a machine which was so nearly perfect in producing the desired end.

The CHAIRMAN, in proposing a vote of thanks to Mr. Rowlett, said the paper had an important bearing on the subject of technical education. They were aware that the Clothworkers' Company were establishing technical schools in Yorkshire, at Leeds, and elsewhere, and the City Guilds had also established one in connection with the lace manufacture. He had himself witnessed, in Germany, the preparations which were being made, in various colleges, for teaching all these subjects; at Vienna, especially, he saw one in which all the operations were being carefully taught to the young people, and it was very desirable, therefore, that we should not be behindhand in this matter. He was glad to think that the feeling was growing throughout the country, and that different towns were taking up the subject of establishing technical schools suitable to their particular industries. Manufacturers also were beginning to see that it was to their interest to do this, and were providing means for establishing such schools. He had recently, in the North, found a new school in a town where weaving was carried on, but where the quality was found not to equal the samples brought from elsewhere, and they found it to be to their interest to establish schools which would improve and refine the quality of the workmanship, so as to make it more acceptable. These views were growing, and the holding of meetings of this kind in the centre of London would tend to popularise them, and make known what delicate operations were carried on in the making of these apparently simple things. On seeing the machinery with which they were produced, they could not but be astonished at the amount of labou and thought displayed in its construction. Now-a days people were beginning to feel, on account of the increase of every description of manufactures, that nothing was more beautiful than something done by hand, and a great many institutions had been established for improving hand-workmanship of all sorts, but he thought it could never compete with the result of machinery, which multiplied the power of production to such an extent that it could only be from a sort of *dilettante* desire to have something different from other people that would ever make this popular; consequently technical education, showing how to produce these machines, and also really artistic designs which should be reproduced by machinery, was becoming of more and more importance.

Mr. NOTLEY suggested some improvements in the make of stockings, and asked if it would not be possible for pieces to be made which could be sewn on or darned in, which method he thought would be a great improvement upon the present system of darning.

Mr. TREWBY asked Mr. Rowlett if he could state the relative payment for labour in Nottingham and in Saxony. Up to the time of the Exhibition of 1862 there were scarcely any stockings from Saxony except a very fine kind of thread, but after that time, the Zollverein having exhibited such remarkably cheap productions, the country was flooded with them. He had been given to understand that this was entirely owing to the miserably low rate of wages paid, and he did not see how technical educa

tion would benefit this country if, after all, we had to come down to the miserable rate of pay which the Germans were receiving.

The vote of thanks having been passed,

Mr. ROWLETT, in reply, said it was possible to make stockings to fit any deformity to which the human frame was subject, and this was actually done. As to making pieces to sew upon them, instead of darning, he thought the remedy would be worse than the disease. It was unpleasant to have a badly-darned stocking, but if a piece were placed over a hole, there would be a double thickness where it overlapped, which would be very unpleasant. There was, some time ago, a stocking invented called a patent renewable stocking, where separate pieces were made to fit in the toes and heels, but it had a very short life, and the present price of stockings was so low that he did not think it was likely to be revived. With respect to the difference between Germany and England, he held that at the outset the low rate of wages abroad had a great deal to do with it, but in those things which were made largely by machinery Mr. Goodall would bear him out in saying that the Germans had never got a footing in England; their goods went chiefly to the United States and other markets. The rate of wages in Germany was rising, and it was to be hoped that it would become assimilated to ours, but it was not entirely the rate of wages which caused the difference. The British workman, he was proud to believe, was unsurpassed and almost unequalled in any country in the world. Only a few days ago, in Nottingham, he was talking to a manufacturer who had had a workman who earned £5 a week on his stocking frame. He was the best workman they had ever had. For some reason they quarrelled with him and he left, and the man who was put in his place to work the machine earned just half as much. The British artisan did more for the same money than the German. Talking of technical education, the present machinery was exceedingly swift, and the Germans were getting the same machinery. We had had for some time the advantage of the swiftest machines, but that advantage we were losing. The lower, however, the price became of making the articles, the less chance had the foreigner of competing. The hosiery trade was in quite as bad a state in Germany as ever it was in England; but technical instruction was being given to their people to enable them to improve their position. It had been a common remark by many of the old manufacturers that they were able to get on without technical instruction, and they did not see why the rising generation should not do the same. But it must be remembered, as Sir Philip Magnus pointed out recently, that the rising generation were not working under the same conditions as their forefathers. The whole world was being more extensively educated, and technical industries abroad had reached a pitch which we could not hope to reach for some years. If we allowed the foreigner, with any natural advantages he might have in the shape of wages, to be better educated than our own men, we should certainly lose ground. It was as much as we could hope to do to keep abreast of our opponents.

Mr. TREWBY said Mr. Rowlett had hardly answered his question. He wished to know, if possible, what were the wages of an ordinary workman—not an exceptionally clever man—in Germany, and in Nottingham.

Mr. ROWLETT said he believed the wages in Germany were about two-thirds of what they were in England.

Miscellaneous.

PARIS EXHIBITION, 1889.

On Wednesday, the 29th ult., a meeting of the London committee now being formed by the Lord Mayor in connection with the Paris Universal Exhibition, 1889, was held in the Mansion-house.

The LORD MAYOR, in opening the proceedings, said he had asked them to give him the pleasure of their company to decide what steps should be taken to secure a proper and adequate representation of British arts, manufactures, and industries, at the forthcoming Exhibition in Paris. In doing so he had responded to the invitation which the French Ambassador, and M. Berger, the director-general of the Exhibition, had made to him. The Government had decided not to take any official part in the Exhibition, though they had undertaken to give all facilities within their power to intending exhibitors. He had received an intimation from the Foreign-office, assuring him that the Government could in no way object to his assuming that position, and stating, without qualification, that Lord Salisbury would in no way regard his presidency as opposing the position which the Government had taken in the matter.

Mr. BRUCE, President of the Institution of Civil Engineers, moved the first resolution—"That, in the opinion of this meeting, it is highly desirable that British arts and manufactures should be properly represented at the Paris Universal Exhibition, 1889, and that the meeting hereby forms itself into a committee for the purpose of securing such a representation."

Sir DOUGLAS GALTON moved that the executive committee be empowered to apportion among British exhibitors the space which might be allotted to Great Britain in the exhibition; to make such charges to the exhibitors as might suffice to cover the costs of the section; to receive and expend all funds subscribed or paid, and generally to take such steps as might be necessary in the interests of the exhibitors and the section. He expressed the hope that the City of London, and the manufacturers of

the country, and those interested in its welfare, would do everything to maintain the good feeling and friendship existing with France.

Mr. AIRD, M.P., moved that the executive committee should also have power to invite subscriptions towards the expenses of the section, and to raise a guarantee fund which should only be called upon in case of the funds from the other sources being insufficient.

The guarantee fund now includes, amongst others, the following contributions:—The Corporation of the City of London, £1,000; the Lord Mayor, £500; the South Eastern Railway Company, £1,000; Chubb and Sons (Limited), £500; Mr. Sheriff Davies, £250; Mr. Sheriff Higgs, £250; Mr. Hawksley, £250; Mr. Aird, M.P., £500; Mr. Ernest Hart, £100; Sir Daniel Cooper, £250; and Mr. E. L. Montefiore, £250; and Messrs. Clowes and Son, £500.

Correspondence.

SCIENCE AND ART DEPARTMENT.

In the last number of the *Journal*, Professor Silvanus Thompson, speaking against the system of the Science and Art Department, illustrates his objection thereto by his own experiences. He is reported, at page 424, to have said:—

"To take a man because he had some proficiency in two or three branches of science, and imagine he could teach every branch, and much more, that he could teach the technical application of all those, was simply absurd. About fourteen years ago he had tried to take advantage of the opportunities offered by the Science and Art Department—and as he knew some physics and a little chemistry—tried, by passing a lot of the May examinations, to get a scholarship to take him up to the Science and Art Department's Normal School. He got the scholarship, and then he was told that he must go into Professor Huxley's laboratory, and learn physiology. He had nothing to say against Professor Huxley's laboratory; no doubt it was the very best of its kind, but physiology was not in his line. He had wanted to study chemistry and physics, and to make himself really competent in these subjects—in fact, to become a specialist really qualified to teach them. But he was told that, as he was weak in physiology, he must go into the physiological laboratory to be made a wholly competent science teacher all round, in order that he might be able to teach classes in physiology. As he did not want to be made into an all-round superficial dabbler, he threw up his scholarship and stuck to physics and chemistry. Was that a system which would turn out teachers competent to give instructions such as the workmen of England want, in the technical applications of science to the industries? The Science and Art Department's notion was to get men who could teach everything—building construction, machine construction, steam-engines, chemistry, mining, zoology, naval architecture, botany, physics, and everything else. That was the sort of science teacher they turned out; a man who taught everything, but knew nothing thoroughly. That was in his opinion the very antithesis of what technical education ought to be."

I regret that, in the following remarks, I must be somewhat personal, but the incident referred to by Professor Silvanus Thompson renders it necessary. His memory has, I fear, in the time that has elapsed, played him false, for I cannot find that Professor Thompson ever obtained a scholarship of any kind to take him to the Normal School of Science. He did apply, on the regular Form, in May, 1875, for a "Studentship in Training." On this form he stated what examinations he had already passed, but made no condition or stipulation as to the subject he desired to take up. He was selected to attend the course in biology—not physiology—having already passed in animal physiology and elementary botany. A teachership in training gave free instruction, and a maintenance allowance of 25s. a week. Professor Silvanus Thompson refused the offer made to him, on the ground that he had signified his desire, in a letter which accompanied his application, to specialise his studies upon organic chemistry. No such letter had been received; the Department had no reason to suppose that he desired to specialise in organic chemistry, for he had done as well in physiology and botany, and the studentships in training in chemistry were full, the numbers being fixed by the capacity of the school, and the need of teachers in various branches of science, and not by the idiosyncracies of the various applicants for admission. Professor Thompson then joined the school as a fee-paying student.

In conclusion, I have only to add that the *curricula* for the various associateships of the school, one of which a "scholar" has to pursue, were framed by the Dean and Council—probably as eminent a body of scientific men as is to be found in the country; and that as regards teachers in training, it has never been the notion to get men to teach everything. Several of the subjects mentioned by Professor Thompson are not even taught in the school. A teacher in training may, if he desire it, confine himself to the study of one subject, and the rule is to restrict him to one group of allied subjects.

J. F. D. DONNELLY.

March 5th, 1888.

TECHNICAL EDUCATION BILL.

In a letter to the *Times*, at the time the Technical Education Bill was introduced last year, I wrote:—

"The subject of technical education is one of great national importance. In consequence of the new

organisation of workshops caused by the extension of division of labour, the old system of apprenticeship which gave to this country its pre-eminence has to a great extent disappeared. The apprenticeship was the educational machinery on which the country relied; that having been pushed on one side, we must now find a substitute. Professors govern us in many things, but when we depend upon them to supply the void caused by the dropping of the apprenticeship system, let us say good-bye to our ancient manufacturing supremacy." In March last, Lord Hartington made a speech at the Polytechnic Young Men's Christian Association, when he said that we must insure the possession of scientific knowledge by the masses of the people. I will now state a principle in entire opposition to Lord Hartington's dictum. If history is to be our guide, highly skilled labour can be the result of no other cause than an apprenticeship of many years, and I venture to add that to any other than the highly skilled mechanic scientific knowledge will be valueless. When Sir William Hart-Dyke visited Bradford, the Council of the Bradford Technical College handed to him a series of resolutions, of which the first was as follows:—"That the improvement and development of our manufactures can only be expected from the technical training of youths of special ability, and not from the technical education of children in general, which would prove most burdensome to the ratepayers, and, so far as improvement in manufactures is concerned, would be comparatively useless."

Adam Smith, 110 years ago, published his "Wealth of Nations," and devoted the first chapter to the question of division of labour. He took the manufacture of pins as his illustration, and showed that the value of a man's labour by what is called division of labour is multiplied at least 240 times. He thus stated the principles:—"The division of labour occasions in every art a proportionable increase in the productive powers of labour. The separation of different trades and employments from one another seems to have taken place in consequence of this advantage. This separation, too, is generally carried farthest in those countries which enjoy the highest degree of industry and improvement; what is the work of one man in a rude state of society being generally that of several in an improved one." Though written more than a century ago, it would be impossible to describe with greater accuracy our present position, for industrial development has proceeded during that period with giant strides, and therefore we need not be surprised that division of labour has been organised more and more, until it has, perhaps, reached its greatest perfection. Though one trade may lend itself to division of labour more than another, yet it is true that the vast majority of workmen are under the influence of Adam Smith's law. There were at that time 18 different stages in the manufacture of pins. Adam Smith described each of these stages, and begun thus:—"One man draws out the wire." Now, this man never varies his occupation, and is unable to perform the work allotted to his fellows; much less is he able by his own handiwork to make a pin. No one can say that he is not a skilled workman, for within the limits of his duty he has attained, perhaps, the highest possible skill. But how narrow are those limits! And may we not say with truth, that, though skilled, he is *quâ* workman only one degree in the scale of creation removed from the machine he directs, or the single tool he uses? What a mockery, then, to offer to such a man the acquisition of scientific knowledge. It is impossible to reconcile the principles here enunciated with Lord Hartington's speech with Sir William Hart-Dyke's Bill, or with the paper read on February 22nd by Mr. Swire Smith, for my principles are founded on the idea that division of labour governs economical production, whereas they never mention division of labour, but, on the contrary, seem to ignore it altogether. There may be those who will ask whether all this cheapness is necessary. I reply that it is, for without it we should starve. The population of this country, in comparison with the capabilities of the soil to produce food, is so vast, that we have now to import of wheat two-thirds of our consumption, and of other grain, of meat both live and dead, of eggs, butter, cheese, fruit, and vegetables, a prodigious quantity. All this is besides articles not produced in this country, such as tea, coffee, cocoa, sugar, rice, tobacco, spices, and a great many more, which it would take too long to enumerate. The only way of paying for these imports is by exports, sent now, sent in the past, or to be sent in the future. If the payment is deferred, it must be made at a future time—capital and interest. If we are consuming imports paid for by exports sent by our forefathers, so much the better for us, and so much the more thankful should we be to our ancestors for their industry and providence. In fact, this is what is now occurring, for we are receiving vast quantities more than we are exporting, the difference representing, it is supposed, the interest on debts due to us from foreign persons and nations. In my published writings I have always treated this interest as £100,000,000 a-year. Still, we have to export enormously, and our customers will not deal with us unless we supply them with goods of good quality at a low price. To sell at a low price the cost of production must be reduced to a *minimum*. Thus the conclusion of the whole matter is that without economical production we must starve, that in order to obtain economical production division of labour and multiplication of machinery are absolutely necessary, that for those who are engaged in this kind of labour technical education is of no value, and that it should be given to those alone who are the leaders of industry, such as foremen, managers, and masters. Still it is to be hoped that in the new system a place will be found for those who will keep up the tradition of the past as highly skilled mechanics, for the British mechanic has always been, is now, and I

hope always will be, the envy of the world. I have no time now to expound the system which I have prepared, suffice it to say that it is founded not on class teaching, but on apprenticeship, as of old.

One word more and I have done. Some day foreign nations will recognise the fact that they are being weighed down by protection, and will throw it off. Then the real struggle for supremacy will begin. Then those who have the greatest theoretical knowledge, the highest practical skill, the most consummate organising power, and the genius of command, will be our generals. But the rank and file need none of these gifts. They must be endowed with the moral qualities of patriotism, industry, obedience, virtue, and truth.

DANIEL WATNEY.

THE LIBRARY.

The following books have been added to the Library since the last announcement:—

Architects' Register. Vol. 2. (London: W. Pope, 1887.) Presented by the Publisher.

Bale, M. Powis.—A Handbook for Steam Users, being the Rules for Engine-drivers and Boiler Attendants. (London: Longmans, Green and Co., 1887.) Presented by the Publishers.

Cochran, William.—Pen and Pencil in Asia Minor; or Notes from the Levant. (London: Sampson Low, Marston and Co., 1887.) Presented by the Author.

Corfield, (W. H.), M.D.—The Treatment and Utilisation of Sewage. Third edition, revised and enlarged by the Author and Louis C. Parkes, M.D. (London: Macmillan and Co., 1887.) Presented by the Author.

Cotton, General Sir A., K.C.S.I.—Thorough Cultivation. (London: Simpkin, Marshall and Co., 1887.) Presented by the Author.

Egleston, Thomas, LL.D.—The Metallurgy of Silver, Gold, and Mercury in the United States. Vol. I.—Silver. (London: *Engineering*, 1887.) Presented by the Editor of *Engineering*.

Ferguson, John.—Ceylon in the Jubilee Year. (London: John Haddon and Co. Colombo: A. M. and J. Ferguson, 1887.) Presented by the Publishers, Colombo.

Hasluck, Paul N.—The Wood Turners' Handybook; a Practical Manual for Workers at the Lathe. (London: Crosby Lockwood and Co., 1887.) Presented by the Publishers.

Hastings, E. J.—The Statistical Atlas of Commercial Geography. (Edinburgh: W. and A. K. Johnston.) Presented by the Publishers.

Liverpool Royal Jubilee Exhibition, 1887.—Official Catalogue; Official Guide; Daily Programme, Sept. 20; and A Sketch by K. C. Spier. (Liverpool.) Presented by the Executive Council. Jamaica at the Royal Jubilee Exhibition, by G. Washington Eves. (London, 1887.) Presented by the Author.

Newcastle-upon-Tyne Royal Mining, Engineering, and Industrial Exhibition, 1887.—Official Catalogue. Official Guide. Illustrated Catalogue of the Fine Art Section. Description of the Model Dwelling, by H. E. Armstrong, M.R.C.S. The Bridges and the Floods of Newcastle-upon-Tyne, by J. Collingwood Bruce, D.C.L., LL.D. (Newcastle-upon-Tyne, 1887.) Presented by the Executive Committee.

Newcastle-upon-Tyne Public Libraries.—Catalogue of the Books in the Juvenile Lending Department. (New Edition.) (London, 1887.) Presented by the Chief Librarian.

Olsen, O. T.—The Fisherman's Nautical Almanack, 1888. (Grimsby.) Presented by the Author.

Slater, J. W.—Sewage Treatment, Purification, and Utilisation. (London: Whittaker and Co. 1888.) Presented by the Publishers.

Tucker, G. A.—Lunacy in Many Lands. (Sydney, 1887.) Presented by the Author.

Yeats, John, LL.D.—Natural History of Commerce, Technical History of Commerce, Growth and Vicissitudes of Commerce, and Recent and Existing Commerce. 4 vols. (London: George Philip and Son, 1887.) Presented by the Author.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 14.—"Agricultural Education and Dairy Instruction." By Prof. JOHN WRIGHTSON.

MARCH 21.—"The Evils of Canal Irrigation in India, and their Prevention." By T. H. THORNTON, C.S.I., D.C.L. Colonel Sir OWEN T. BURNE, K.C.S.I., C.I.E., will preside.

APRIL 11.—"Recent Legislature concerning the Pollution of Air or Water." By ALFRED E. FLETCHER, Chief Inspector of Alkali, &c., Works.

APRIL 18.—"Telescopes for Stellar Photography." By Sir HOWARD GRUBB, F.R.S.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 20.—"What Style of Architecture should we follow?" By WILLIAM SIMPSON. Prof. T. HAYTER LEWIS will preside.

This paper was previously announced for May 8, when it is now arranged that Mr. Crace's paper shall be read.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 27.—"The Panama Canal." By J STEPHEN JEANS.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D. Sir WILLIAM W. HUNTER, K.C.S.I., LL.D., will preside.

CANTOR LECTURES.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

LECTURE I.—MARCH 12.—Sketch of early investigations on alloys.—Development of views as to their constitution from the time of Réaumur (1722) to that of Matthiessen (1860).—Recent investigations.—Formation of alloys by fusion.—Results obtained by compressing the finely divided constituent metals.—Evolution and absorption of heat attending the union of metals.—Production of ice by the aid of amalgamation.—Debray's explosive alloys.

DR. MANN LECTURES.

Two lectures will be delivered by Professor Oliver J. Lodge, D.SC., F.R.S., on the "Protection of Buildings from Lightning," on Saturday afternoons, March 10th and 17th, at 3 o'clock.

LECTURE I.—MARCH 10.—Historical sketch.—Outstanding questions.—Difficulties and points of controversy in connection with lightning conductors.

LECTURE II.—MARCH 17.—Experimental answers to some of the questions raised, and a more complete theory of the liability of conductors to side-flash than has yet been given.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys" (Lecture I.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Douglas W. Freshfield, "The Peaks, Passes, and Glaciers of the Caucasus." (With Lantern Illustrations.)

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Ernest Pauer, "Characteristic Qualities of the Works Produced by the Great Composers."

TUESDAY, MARCH 13...Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 2 p.m. Annual Photographic Conference and Exhibition.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture IX.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p m. Mr. P. W. Willans, "Economy Trials of a Non-Condensing Steam-Engine—Simple, Compound, and Triple."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Cuthbert Peek, "Exhibition of Inscribed Tablets from Babylon." 2. Mr. G. Bertin, "The Races of the Babylonian Empire from the Monuments."

Colonial Institute, Whitehall-rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Mr. J. Henniker Heaton, "The Postal and Telegraphic Communication of the Empire."

WEDNESDAY, MARCH 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. John Wrightson, "Agricultural Education and Dairy Instruction."

Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 2 p.m. Annual Conference. Reading of papers and discussion continued.

Geological, Burlington-house, W., 8 p.m. 1. Rev. J. F. Blake, "The Monian System." 2. Mr. Howard Fox, "The Gneissic Rocks off the Lizard," with Notes on Specimens by Mr. J. J. H. Teall.

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Mr G. Massee, "The Type of a New Order of Fungi."

Pharmaceutical, 17, Bloomsbury-street, W.C., 8 p.m.

Huguenot, Criterion, Piccadilly, W., 8 p.m. 1. Mr. W. J. Hardy, "Foreign Refugees at Rye." 2. Mr. W. Minet, "A Relation of our Family."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual General Meeting.

Civil and Mechanical Engineers, Town Hall, Westminster, S.W., 7 p.m. Mr. A. C. Schönberg, "The Construction and Use of the Hopper Dredger."

THURSDAY, MARCH 15...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. George Massee, "Monograph of the *Thelephoreæ*. 2. Mr. Edward A. L. Batters, "Descriptions of three new Marine Algæ." 3. Mr. J. E. Harting. "Exhibition of the *Os frontalis* of a Hornless Stag, with remarks on such abnormality."

Chemical, Burlington-house, 8 p.m. Ballot for the Election of Fellows.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. E. Riley, "A Generation's Changes in the Manufacture of Iron and Steel."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Miss M. A. Chreiman, "Physical Culture," with practical demonstration.

Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. H. Dallinger, "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life." (Lecture II.)

Historical, 11, Chandos-street, W., 8½ p.m. Mr. Arthur R. Ropes, "Frederick the Great, and the First Silesian War."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Home Education Society (at the HOUSE OF THE SOCIETY OF ARTS), 8 p m. Lecture by Prof. Henslow.

FRIDAY, MARCH 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Dr. F. J. Mouat, "The Origin, Progress, and Influence of Universities in India."

United Service, Whitehall-yard, S.W., 3 p.m. Major General W. E. Macleod, "The History of the Native Army of Bombay from 1837-87; its Constitution, Equipment, and Interior Economy, founded on Personal Service with it during Thirty-seven Years' active service in India."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p m. Mr. John Murray, "The Structure, Origin, and Distribution of Coral Reefs and Islands."

Philological, University College, W.C., 8 p.m. Mr. T. O'Flannaoile, "Irish-Gaelic Dialects."

SATURDAY, MARCH 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Dr. Mann Lectures.) Prof. J. Oliver Lodge, "Protection of Buildings from Lightning." (Lecture II.)

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Modern Drama—Scandinavian."

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FRIDAY, MARCH 16, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ADDRESS TO H.R.H. THE PRESIDENT.

The following address to H.R.H. the Prince of Wales, President of the Society, has been presented to His Royal Highness:—

To his Royal Highness the Prince of Wales, K.G., &c., &c., &c.

May it Please your Royal Highness.

We, the Members of the Society for the Encouragement of Arts, Manufactures, and Commerce, desire to offer to your Royal Highness our sincere and heartfelt congratulations on the occasion of the twenty-fifth anniversary of your Royal Highness's marriage.

We gratefully remember that at the completion of the current Session of the Society, your Royal Highness will have been for twenty-four years President of the Society of Arts, and we feel that this Society owes very much of its prosperity during that time to your Royal Highness's influence, and to the great interest your Royal Highness has taken in its affairs.

We earnestly desire that for many years to come you and your Royal Consort may be spared to retain the high position you both hold in the respect and affections of the people of this country; and we trust that the period on which you are now entering may be no less happy than the one you have just completed.

Sealed with the Seal of the Society for the Encouragement of Arts, Manufactures, and Commerce, this fourteenth day of March, 1888, in the presence of (L.S.)

Douglas Galton,
Chairman of Council.

H. Trueman Wood,
Secretary to the Society.

EXAMINATIONS IN PRACTICAL COMMERCIAL KNOWLEDGE.

With a view of rendering the Society's Commercial Examinations more practical and technical, the Council have decided to examine candidates who have passed the general examination for Commercial Certificates in subjects relating to different branches of Commerce.

For the present year it is proposed to hold an Examination in two Divisions:—

I. The Commerce of Food.
II. The Commerce of Clothing.

Other divisions will be added as experience may show to be desirable, and these divisions will also be further expanded.

Division I. will for the present include only the following branches of trade:—1. Grain and Breadstuffs. 2. Tea, Coffee, Cocoa. 3. Sugar.

Division II. will for the present include the following:—1. Wool. 2. Cotton. 3. Linen.

One paper will be set in each division, containing questions referring to each sub-division. The candidate will be expected to select those questions bearing upon his trade, and full marks for the paper can be obtained by answering a portion only of the questions.

The Syllabus has been framed so as to correspond generally with the main divisions of trade, but it has not been found practicable to divide it up so that it may correspond with numerous branches into which every trade is divided. Candidates are, therefore, expected to judge for themselves which portion of the paper will best suit them. In all cases credit will be given for evidence of special knowledge.

In both divisions, candidates for examination will be expected to answer questions as to sources of supply of the various products, the countries producing them, their nature, methods of testing, substances used in adulteration, values, methods of importation, cost and methods of transport, foreign markets, discounts, trade allowances, shipping insurance, customs duties, &c.

When possible, the candidate may be required to examine and report on samples of the goods. He must be familiar with the technical terms used in this branch of commerce, and will be expected to make out bills of lading, invoices, &c., and must show a capacity for conducting commercial correspondence relating to the special trade. If he

can do this, and show a fair colloquial knowledge of the language of the country with which the trade is likely to be concerned, he will receive a considerable increase in marks.

Before he can receive a Commercial Certificate, the candidate must have passed the following preliminary tests, or other approved examinations :—

Arithmetic—First-class in Society of Arts Examinations, or the University Local Examinations, or the Examinations of the College of Preceptors.
Modern Languages. The same (in any one language).
Book-keeping. Ditto.
Commercial Geography. Ditto.
English. Ditto.

Additional marks, which will be counted both for the classes and prizes, will be given to candidates producing certificates of having passed the Examinations of the Science and Art Department in
Chemistry, Physics, Botany, Physiography.
Freehand or Mechanical Drawing,
Or of the Examinations of the City and Guilds Institute in any of the subjects associated with his trade.

SYLLABUS.

Division I.—Commerce of Food.

1. *The Grain Trade (including the trade in Rice and other Grains).*—Sources of supply, domestic, colonial, and foreign. Qualities and characteristics of various grains, &c. Preparation for market (*e.g.*, husking, cleaning, and polishing rice, cleaning grain). Methods of milling (a general, not a technical knowledge of these portions of the subject only required). Methods of verifying quantities delivered and received. Statistics of production, import, &c.

2. *Trade in Tea, in Coffee, and in Cocoa.*—Sources of supply. Botany of the subject; varieties from different countries; hybrids; characteristics of the plants; diseases of the plants; insect pests; climate and rainfall; soil and treatment required. Preparation of of the raw product; its after treatment. Methods of manufacture. Causes affecting increase or decrease of supply. Chemistry of tea, of coffee, and of cocoa; statistics of production, import, &c.

3. *Sugar Trade.*—Sources of supply. Characteristics and qualities of sugars (cane and beet). Manufacturing processes—extracting juices, clarification, evaporation, boiling in vacuo, composition and treatment of molasses, fermentation and distillation (a general, not a technical knowledge of these portions of the subject only required). Methods of analysis.

Division II.—Commerce of Clothing.

In this division, general questions will be asked relating to the sources from which the raw materials are derived, the producing countries, capacities of newly-settled lands. Manufacture of the raw materials, and the fabrics produced from them; pure fabrics (*e.g.*, *union* goods, *merino* hosiery, &c.); utilisation of waste, adulterated fabrics, resurrected materials, *shoddy*, *mungo*, *rag-wools*. The home market, its extent, character, and requirements. Colonial and foreign markets, their geography, number, extent, populations, capacity for consumption. Competition with other nations. Exports and imports, statistics.

Also special questions in the following subdivisions :—

1. *Wool Trade.*—Sources of supply. Characteristics and qualities of various wools. Various breeds of sheep, goats, and other hair-producing animals. Influences of climate on the breed and on the fleece. Treatment of raw product. Processes, apparatus, &c., used in the manufacture of woollen, worsted, and mixed goods; wool-dyeing (a general, not a technical knowledge of these portions of the subject only required). The wool trade, exports and imports, statistics.

2. *Trade in Cotton and Cotton Goods.*—Cotton and cotton plants. Characteristics and qualities of the leading classes. Sources of supply, and quantities from each. Treatment in country of production previous to export. Liabilities to natural or artificial adulteration. Commercial handling of cotton previous to its reaching the spinner. The processes and apparatus of manufacture up to the stage of a woven fabric. Plain, twilled, figured, and "fancy" cloths, and their suitability for different markets. "Finishing," in its varieties of bleaching, dyeing, or printing (calico). Packing and commercial handling in the course of distribution to the consuming countries. Calico printing and dyeing (a general, not a technical knowledge of these branches of the subject only required). The cotton trade, imports and exports, statistics.

3. *Trade in Linen and Linen Goods.*—Sources of supply. Growth and treatment of flax. Processes, apparatus, &c., used in the

manufacture of linen goods (a general, not a technical knowledge of these portions of the subject only required). The linen trade, imports and exports, statistics

The first examination in London will be held in June next, and further particulars as to date will be duly announced.

BARCELONA EXHIBITION, 1888.

At the request of the Secretary of State for Foreign Affairs, the Society of Arts has undertaken to promote the interests of the Exhibition in this country, and to act as the intermediary between British exhibitors and the Executive of the Exhibition. The Exhibition is announced to be opened on the 9th April, and the date for the receipt of applications from foreign exhibitors has already passed. A request for an extension of the time has been made to the Spanish Executive, who have consented that applications for space (except for machinery) shall be considered until the end of the present month. In the meantime, British manufacturers who wish to take part in the Exhibition, and have not already sent in applications for space, may apply to the Secretary of the Society of Arts,

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1888 early in May next, and they therefore invite members of the Society to forward to the Secretary, on or before the 14th of April, the names of such men of high distinction as they may think worthy of this honour. This medal was struck to reward " distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michael Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Amstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France. For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister.

In 1887, to HER MAJESTY THE QUEEN.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

CANTOR LECTURES.

The second and concluding lecture of the course on "The Modern Microscope" was delivered on Monday evening, 5th inst., by Mr. JOHN MAYALL, jun., when a large collec- of microscopes was exhibited.

A vote of thanks was passed to the lecturer on the motion of the CHAIRMAN (Mr. Francis Cobb).

Professor CHANDLER ROBERTS - AUSTEN delivered the first lecture of the course on "Alloys" on Monday evening, 12th inst. The lecture was illustrated by a series of experiments.

These lectures will be printed in the *Journal* during the summer recess.

DR. MANN LECTURES.

The first lecture of this course, on the "Protection of Buildings from Lightning," was delivered on Saturday afternoon, 10th inst., by Professor OLIVER J. LODGE, D.Sc., F.R.S. The second and concluding lecture will be delivered to-morrow (Saturday) afternoon, 17th inst.

These lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 14th, 1888; WILLIAM ANDERSON, M.Inst.C.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Baker, Theodore, B.Sc., 35, Overcliff, Gravesend.
Bickersteth, Very Rev. Edward, D.D., Dean of Lichfield, The Deanery, Lichfield.
Ouseley, Rev. Canon Sir Frederick A. Gore, Bart., M.A., Mus.Doc., LL.D., St. Michael's, Tenbury and The Close, Hereford.
Shields, Rev. John Samuel Sandys, D.D., Linden-villa, Westcombe-park-road, Blackheath, S.E.
Williams, John, 63, Warwick-gardens, Kensington, W.
Withers, James, 1, Culver-terrace, Sandown, Isle of Wight.

The following candidates were balloted for and duly elected members of the Society:—

Oates, Rev. Alfred, Christchurch Vicarage, Ware, Herts.
Stannus, Hugh, 61, Larkhall-rise, S.W.
Statham, Henry Heathcote, 40, Gower-street, W.C.
Tough, John James, 13, Benthall-road, Stoke Newington, N.
Tunley, George, 3, Foley-avenue, Hampstead, N.W.
Veevers, Richard, Woningworth, Fulwood-park, near Preston.
Whiteley, George, 733, Commercial-road, E.
Whiteley, Richard William, 1, Friar's Stile-villas, Richmond, Surrey.

The paper read was—

AGRICULTURAL EDUCATION AND DAIRY INSTRUCTION.

BY JOHN WRIGHTSON, M.R.A.C., F.C.S.

The subject of agricultural education has been forced into importance by the general depression, which, like a black and impenetrable cloud, has hung over the business world for many years. It forms part of the great question of technical instruction in the arts, for the solving of which a Royal Commission was appointed so long since as 1882. It is the same great question which drew together a large and influential meeting in this room last July, presided over by Lord Hartington, for the purpose of inaugurating a National Association for the promotion of Technical Education. It is a subject of vast importance, and one upon which the nation has already spent millions sterling, with greater cheerfulness and less of questioning than it has spent lesser sums upon its armaments.

We are assembled here to-night to discuss the bearings of this great subject of technical instruction upon agriculture. It was only on the 4th of May last that we met for a similar purpose, under the presidency of Sir Thomas Dyke Acland, and heard a most able, a most genial, and most practical discourse, from that eminent authority on this subject, Mr. John Chalmers Morton. Since then much has happened. The British Dairy Farmers' Association has become, in addition to its other functions, an examining body, having conferred its first three diplomas and a certificate last June. In September, a Departmental Commission, under the presidency of Sir Richard Paget, was instructed to inquire into the best methods of assisting agricultural colleges and schools by Government grants. Since then we have had the results of the deliberations of this committee, which I must presently notice, and, almost simultaneously, a pledge given in the House of Commons, by the Duke of Rutland (then Lord John Manners), that some of the recommendations of this Commission should be included in a measure intended for the benefit of agriculture. This is to be accomplished by the formation of a Department, and the appointment of a Minister of Agriculture, one of whose functions would probably involve instruction in agriculture.

Since the issue of the late Mr. H. M. Jenkins's exhaustive report upon agricultural education, under the Royal Commission on Technical Instruction, in 1884, the subject has slumbered, but now that there appears to be a prospect of its forming a part of practical politics, and of being included in the Estimates, it is time that it should be looked at critically, carefully, and dispassionately, with a view to really finding what is the best thing to be done.

While in a certain sense the matter has slumbered since the Commissioners' Report already mentioned, it has not been neglected. It was the subject of an important Conference at the Health Exhibition, organised by Lord Reay, Mr. B. St. John Ackers, and others, at which I had the honour of contributing a

paper and of listening to several others. As a constant reader of the agricultural papers, I have noticed that scarcely a week has elapsed during the last twelve months in which some opinion has not been expressed regarding agricultural education, or some suggestion vouchsafed. In endeavouring to give a general idea as to the results of the Conference at the Health Exhibition, and much writing from known and unknown correspondents on the subject, I am led to notice the following broad distinctions or deviations of opinion among thinking men.

First there are very many who consider that the best preparation for farming is a good general education conducted upon the lines usually followed in good schools. Whether classics and mathematics, or modern languages and science are to predominate may be a matter of further divergence, but the basis of business success is a sound general education. Thus Mr. Morton at once expressed himself in favour of "Schooling before Farming." As he himself put it, "the whole business of the hour, so far as he was concerned, would be to insist upon it that the preliminary schooling was by far the most important part of an agricultural or of any other education." I do not for a moment believe that Mr. Morton is antagonistic to a scientific basis for practice. Such a conclusion would be little less than an aspersion, and would be contradicted by his whole life. Still Mr. Morton thought he joined issue with me when he wrote as follows:—"Professor Wrightson says—'A perfect agricultural education should include geology, biology, engineering, drawing and architecture, chemistry, rural economy, commercial knowledge and book-keeping, law, and meteorology.' However desirable all this may be for a future professor, the young farmer certainly does not need it all. I do not think, indeed, it would be a good thing to take him out of his father's guidance." I entirely agree with Mr. Morton, but must tell him that I was describing a perfect agricultural education, and not the education of a young farmer, which is quite a different matter. I cannot leave so respected an authority without quoting his real heartfelt opinion as expressed in this room last spring. "And I give it," says he, "for my opinion on a review of all these two-and-forty years—in the interest not of one class but, as I firmly believe, in the interest of all—that the best possible preliminary education is needed, not merely to make the boy stronger and more capable as a future farmer, but to fit him for something else as well—if that should fail him." Mr. S. B. L. Druce, Secretary of the Farmers' Club, expressed himself similarly at the Conference on Education at the Health Exhibition. "During the whole time his (the boy's) education should be general, and not special or technical; that is to say, the boy who is intended for a farmer should (speaking generally) have the same education as boys who are intended for other callings in life." Again, "I wholly and entirely disagree with the idea of having farms for educational purposes connected with the county or any other middle-class schools—'school-farms'—as Mr. Jenkins calls them." "Such a plan appears to me to be wrong in principle, and wholly impracticable and unworkable. I think you would be likely to give him a distaste for farming if you taught it as part of a school course." Mr. Hunter Pringle also "admires the full education given in Scotland, not exclusively with a view to agricultural pursuits. A complete classical and mathemathical education, followed with two years in a commercial office." Again, he says, "I have no standard for farmers' sons. I say there ought to be no boundary line. My desire was to show that a really full and liberal education, embracing trigonometry and Livy, was desirable." These expressions of opinion appear to me to be both wise and practical; for surely education is in the truest sense the leading out of the man, or of the mind, from its own narrow surroundings and interests. An educated man is a free man, and not a drudge, nor yet possessed with a soul-absorbing concentration on his "bread-study." With certain slight modifications, we may agree in the general proposition that school-boy days should be devoted to the acquirement of sound general education, and that the technicalities ought to be postponed to a later period.

And yet, self-evident as are many of the above conclusions, there is another view of the case upheld by many who endeavour to combine technical instruction with the ordinary educational course. It is the principle of the school farm advocated by Mr. Jenkins, and borrowed from the French system of *Ecoles pratiques d'Agriculture*, and in a less degree from the German *Landwirthschaftsschulen*. The function of these establishments is to provide a continuation of general and technical education for the sons of tenant farmers and small proprietors.

Such schools as Aspatria, in Cumberland,

and the King Edward's School, near Banff, are examples of schools of this nature in Great Britain; and for a certain class they have their advantages. I am, however, disposed towards Mr. Druce's view, that general education is enough burden to lay on a boy during his early years, and so far as technical education goes, I should prefer that he should enjoy a little farming and a little practice among his father's cows, and sheep, and horses during his holidays, in a thoroughly spontaneous and enjoyable manner. Absolute training in technicalities may well be put off till a later period. It would likewise be easy to show conclusively, from evidence adduced from foreign experience, that the system of mixing technical and general instruction has never been very satisfactory. In Denmark, where agricultural education has, or is supposed to have, done so much for dairy industry, practical and theoretical education are kept rigidly apart, and a system of apprenticeship on a farm, with due certificates as to general and scientific education, are the methods relied upon.

The Higher Technical Education (Landlord, Agent, Surveyor).

No one doubts for a moment that technical instruction is absolutely necessary, whether gained by long years of bitter experience, or by the pleasanter paths of apprenticeship or pupilage. All great masters have had disciples, pupils, apprentices, who waited upon them, and followed their footsteps. This no one doubts, and it is, therefore, unnecessary to take up the time of the meeting by proving it. The question is—How is it best done in the particular case before us, namely, that of agriculture? Let us at once recognise the essential differences as well as resemblances in the three cases which really take up the whole agricultural field. I allude to the differences between landlords, farmers, and labourers. These three classes form, it must be allowed, a definite series, giving rise to Mr. Jenkins's classification of an upper, middle, and lower agricultural education. The division is at once natural and inevitable, and is recognised in all countries. Alike in Germany, France, and Belgium, provision is made for the higher, the intermediate, and the lower agricultural education. There is no escape from this conclusion, and the more clearly it is appreciated, the less likely are we to fall into confusion. When doubt is thrown upon the value of the higher agricultural education, with its chemistry, geology, botany, physiology, political economy, forestry, and theoretical agriculture, to an honest farmer of the farmer class, the doubt is well founded, and I join with Mr. Morton heartily when he says, "the young farmer certainly does not need it all." In this I believe Sir Thomas Dyke Acland concurs, and it has always appeared to me that much misunderstanding would be avoided if we would remember that the kind of knowledge required by legislators, landlords, commissioners, professors, great agriculturists and agents, differs in important respects from the knowledge required by the ordinary tenant of from 250 to 500 acres of land; just as the knowledge required by such a tenant differs from the sort of knowledge needed by the labourer, the carter, or the shepherd. Such differences exist, and we are not responsible for them; it is nevertheless our duty to provide for them. More attention has, I admit, been bestowed upon the higher education than upon the middle and the lower, and it is not difficult to account for this preference. In the first place, the points of contact between it and scientific and historical, or legal knowledge, are much more numerous. The adaptability of various soils and situations to different systems of cultivation, the theory of fertilisers, the comparative merits of different breeds of animals, the history of agricultural progress, the laws of health, the origin and propagation of disease, the planting of timber, and many others of the subjects we teach, are of evident value to the large landowner or his agent. In other cases they bring with these acquirements possibilities of rising in the world to positions of eminence, and they throw an interest around country affairs. Superimposed upon public school and university education, they complete and embellish the inner man, and are at once seen to be desirable. They assist the county member in his speech, the magistrate in his judgment, the agent in his agreements or his advice to tenants, the surveyor in his arbitrament. They are required by examining bodies such as the Surveyors' Institution, the Royal Agricultural Society, and the Highland Agricultural Society, and this alone causes them to be studied. There is, in fact, a demand for this kind of agricultural education, and the demand has been met in this country and more than met in other countries. If this were all, we should be able to prove not only the value of the instruction, but that ample means exist for obtaining such knowledge.

The difficulty does not lie here. The classes interested can pay for their instruction, and it would be strange indeed if a healthy demand of this kind should not call up a supply of the article needed.

THE MIDDLE TECHNICAL EDUCATION (THE FARMER, OR STEWARD).

The best preparation for a young man intending to be a farmer, is a question which I should keep separate from the best preparation for a man who will eventually preside over a number of tenants. The aims are narrower, and the objects more urgent, in the direction of immediate commercial success. Thorough business knowledge, coupled with bodily activity, manual dexterity, sharpness of eye, strong commercial instincts, strong will, acute perceptions, tact, skill, and knowledge of mankind—these are the qualities we must endeavour to cultivate. If it is objected that these qualities are as important for the landlord or the agent as for the farmer, I would observe that the cases differ chiefly in degree. The farmer must necessarily keep his attention on routine—on minutiæ—on a host of small circumstances and small transactions. He is constantly required to settle such questions as to which horse is to go into which cart, which collar has to go on to which horse; concerning petty repairs of implements, orders for oil, sack-twine, tar-line, or plough-shares. He is often called out to examine animals suffering from illness or accident; he is the final court of appeal in all cases, and must know everything that goes on upon his limited area—from the death of a fowl to the threshing of a wheat rick. The other case is different. The issues are larger, and the duties rather those of direction, suggestion, and administration. The large farmer, holding several farms, each looked after by an able foreman, or bailiff, is certainly in the same position, and requires to exercise qualities of deliberation, administration, and organisation.

Now, how are we to give the maximum benefit to a man whose life is to be spent in successfully managing a farm without a bailiff, so as to make his business pay, maintain a family, and keep up the high character for skill and knowledge of his business now possessed by the British farmer? I hope my hearers know the man. I have known him for upwards of thirty years. He is healthy, hardy, skilful, judicious, combative, respectful, acute, and thoroughly well up in his business. All are not so, but I say advisedly, that our farmers are a grand set of men, holding their own through long years of depression, ever hoping, ever striving, ever cheerful. He is the very man to beget a son in his own image, and you cannot look at the rising generation of our farmers without seeing that they will follow on in the same straight line. Gentlemen, let me tell you one thing with reference to teaching these men their business—if you want to teach them anything about land, or stock, or crop, or market, you must begin with them when they are very young; otherwise you will find that the tables are turned, and that they are, in many cases, wiser than their teachers. Again, I ask how are we best to equip these young men for their business? I unhesitatingly reply—by giving them a sound, general education, and leaving the rest to their fathers. Do you suppose that any agricultural professor can instruct these youths as well as a thoroughly experienced farmer? If so, I can tell you that the professors learn what they know of practice from the farmers. The more a professor of this art mixes with farmers, and hears their views, the better teacher he will be. Scientific instruction, to be worth anything, must be controlled, checked, modelled upon practice, and no teaching is worth attending to that does not carry with it the impress and the sanction of practice. The British farmer is an adept in his business, and it is a difficult matter to improve him. A sound education, and a period of pupilage at home, or with another good farmer—or both. Or, in addition to this, a year or two in a commercial office or bank—as is the excellent system pursued in Scotland. Or, in other cases, a year or two at an agricultural college, when the parents can afford the time and the money.

The suggestion of "farm schools" (a term used in contra-distinction to school-farms) is very excellent. It is a modified form of farm pupilage, and upon its excellencies there is an agreement between the advocates for the ordinary elementary education, and those who wish to combine elementary education with technical instruction.

The late Mr. H. M. Jenkins suggested, "that in each county there should be selected a good farm, the tenant of which would agree, under certain terms, to take agricultural apprentices for a term of, say, two or three years. It would be a great advantage if, to each of these farms, there could be attached a teacher, capable of continuing the general, or special, education of the apprentices, by lessons given chiefly in the evenings. The

remainder of the teacher's time might be employed by him according to local circumstances, or he might be the master of of a neighbouring school. . . . The apprentices should be entitled to pass the examinations of the Science and Art Department in the same way as pupils of science classes, and to earn for themselves and their instructors all the distinctions and rewards that are given to pupils and teachers in elementary schools and science classes. The apprentices should be selected from the candidates who distinguish themselves most in an examination held annually in connection with that of the Science and Art Department: and to a great extent the same questions might suffice for both examinations." Mr. Jenkins further suggested that the selected farmer at the head of such an institution might be designated by the title of director, and that other means should be employed to give shape, dignity, and support to the system.

The system is intended as an adaptation of the German *Ackerbauschulen*, and the French *Fermes-écoles*, which are State-aided institutions in which principles and the best practical methods are inculcated, actual work is done by the pupils, and their general and special education is simultaneously attended to. The proposal is worthy of careful attention, first, because no one was better able to form an opinion on such a subject than the late Mr. H. M. Jenkins, and also as showing that to him it appeared that when really good instruction could be obtained upon a farm, on the general principle of apprenticeship, nothing better could be suggested or attempted. If, in addition to the above, scholarships were offered for competition at the farm schools, to be held at the higher-class agricultural colleges, whereby the expense of the education of these establishments could be brought within reach of the best students of the farming class, I think the arrangement would work. From what I know of the habits and opinions of farmers, I believe there is no danger of over competition for such scholarships. Farmers are not much taken up with the idea of collegiate instruction. They mistrust it, and do not think that the knowledge gained at such colleges will compensate for the time required in gaining it. I shall enter presently more minutely into the matter, as bearing upon certain suggestions lately made with reference to the forming of State-aided agricultural colleges. I will not say that an agricultural college might not be of great value to a farmer, but I will say this much—that no agricultural professor can compete with a thoroughly typical, well-informed, and successful farmer in knowledge of the art. There are two, or more, ways of looking at this question. If you wish to make a man a good and successful farmer, he cannot obtain the necessary knowledge so well as among farmers. If you want him to rise out of his class—to be able to talk, to make speeches, to discuss points, and attain a certain reputation as a talker and writer, whereby he may advance his own ends—then, I grant that a college training will greatly assist him. It is, however, open to doubt whether it will enable him to fatten a bullock, to grow a crop, or to make his farm pay better. It must, however, be allowed that the man who can arrange and express his ideas is, in these days, much more likely to push his way; and, therefore, a college training may be of the utmost use to a young man, and its sequel may easily be an improved social and professional position. Such a result is, however, only for the few. I have been connected with agricultural colleges for twenty-five years, and can testify to the exceedingly small number of men—not, I am convinced, one in five hundred—who climb the ladder of fame by taking advantage of the opportunities afforded of scientific knowledge in connection with agriculture. We are, therefore, thrown back upon the usual practical result that the good practical farmer grows as good crops, fattens as much beef and mutton, and arrives at as good general results, as the man who has enjoyed all the advantages of scientific instruction.

Travelling Instructors.

For the benefit of those actually engaged in dairy farming, the system of travelling instructors is well worthy of attention. Last December a dinner was given to Mr. Drummond, the itinerant lecturer to the Ayrshire Dairy Association. The agent to the Duke of Portland (Mr. Turner) stated that at the great Kilmarnock Show in 1884, previous to their engaging Mr. Drummond, Ayrshire cheese makers only secured £5 in prizes in the open classes. The next year, the first in which instruction was given, they secured £45; in 1886, £76; and in 1887, £156. The Highland and Agricultural Society gives an annual grant to different counties for this purpose, and the results have been most satisfactory. Instruction of this kind given on the spot, and with due consideration to the peculiarities of the district,

and even the particular farm where it is imparted, is no doubt of the greatest possible practical value, and is much better than instruction given at a dairy school at a distance, where the apparatus and fittings will be likely to err on the side of being too perfect. Professor Carroll, of Glasnevin, Dublin, himself assured me that the too elaborate nature of the dairies and fittings at model dairies had proved a hindrance rather than a help. Here would add a remark upon the instruction of dairymaids. It is scarcely to be recommended that young women of this class should attend colleges at a distance from their homes. Instruction in village schools will occupy our attention for a few moments further on, but I may say in this connection that much valuable information might be given to girls in rural schools which would be useful to them afterwards in the capacity of dairymaids as well as in domestic service. For the instruction of dairymaids by the travelling lecturers in local centres, where several of them could meet the instructor, and hear his explanations as well as watch his demonstrations, it would not be difficult to arrange local classes at the house of a good dairy farmer, when the meeting of the young women might be made a most agreeable event in their lives, and equally useful as pleasurable. A few lessons would suffice for girls already familiar with the usual and received methods of their respective districts.

The Lower Agricultural Education (The Bailiff And Labourer).

Under this heading we have to consider the case of the labourer, including the bailiff, because the best bailiff is the labourer of extra intelligence who, by his ability and force of character, rises into the position of a bailiff. Good men of this class are very scarce indeed, and any suggestion which would tend towards the increase of their numbers will be welcome. The adoption of a system of general education throughout the country, such as is now happily in existence, will doubtless bear fruit in this direction, and it is a great question whether any better course can be recommended than that of sound education in the "three R's," followed up by years of practice in all the details of farm work. I would further suggest that the principles upon which agricultural practices are based should be taught in all rural schools, instead of far-fetched information upon subjects entirely beyond the *entourage* of the pupils. An examination of the existing Schedules I. and II., of standards of examination, shows that agriculture may be taught especially under the class subjects of Schedule II., Standards IV. to VII., as follows:—

Standard IV.—(*a*) Animals or plants, with particular reference to agriculture; (*b*) substances employed in arts and manufactures; (*c*) the simple kinds of physical and mechanical appliances, *e.g.*, the thermometer, barometer, lever, pulley, wheel and axle, and spirit level.

Standard V.—(*a*) Animal or plant life; (*b*) the chemical and physical principles involved in one of the chief industries of England, among which agriculture may be reckoned; (*c*) the physical and mechanical principles involved in the construction of the commoner instruments, and of the simpler forms of industrial machinery.

Standard VI.—The preceding in fuller detail.

Standard VII.—The preceding in fuller detail again.

Mr. T. Wilkinson, head master of the Harrow Board School, has produced a suggested schedule, in which the preceding sections are transferred to Schedule I., with the addition of practical work in the school garden, elementary agriculture given practically; a progressive course of simple lessons, adapted to cultivate habits of exact observation, statement, and reasoning.

I venture to assert that the above are very valuable suggestions, which ought to be put into practice with as little delay as possible.

The basis of instruction for a bailiff is practical knowledge, but if, by well directed instruction, the boy can be made to think as well as to imitate, while, at the same time, he receives the rudiments of a good general education—his chance of rising in the world, and becoming a valuable director of work, must be greatly increased. In order further to indicate the many valuable lessons which might be taught in the school-room, to sons of small farmers and labourers, I would mention the following:—

1. The comparative values of hay, wheat straw, oat straw, barley straw, pea and bean haulm, as fodder.
2. Comparative values of concentrated foods and root crops.
3. Advantages of autumn cleaning of land.
4. Various modes of cultivating land.
5. Rotations of crops.
6. Exhausting and renovating crops.

7. Value of farm-yard manure, and best means of preserving farm-yard manure.

8. Proper systems of feeding horses and live stock.

9. The steam-engine.

10. The construction of threshing machines, winnowing machines, and various other implements.

11. Comparative advantages of steam, horse, and manual power.

12. Arrangement of labourers in various descriptions of work.

13. Various breeds of domesticated animals and their points, &c.

If it is objected that such knowledge appertains rather to the master than to the man, I am ready to discuss the question further, and to modify the syllabus. The chief object in producing it is to show the large number of subjects which might form material for exercising and catechising boys who may, at some future time, be entrusted with the management of farms, in the capacity of foremen or of bailiffs. It should also be remembered that upon a large farm there are many responsible offices, such as shepherd, dairyman, head-carter, engineer, barn-man, &c., who may well be regarded as skilled men, and who would be much the better for knowing the rational principles of their callings.

I will take the liberty of quoting from a paper by Professor Fream, read before the British Association last September, upon preventible losses in agriculture:—

"The village school affords an admirable means whereby much useful instruction might be imparted to country lads, to their immediate intellectual benefit and to their subsequent welfare. For instance, attractive object-lessons in botany and entomology might be made the means of familiarising boys with the habits and life histories of farm pests, and would foster in them the practice of independent observation, so that in years to come for each pair of eyes now at work there might be thousands. It surely would not be difficult to interest an intelligent village boy in the natural history of wire-worms and leather-jackets, of turnip 'flies' and sawflies, of birds and insects which help the farmer, and of those which injure him, of the good grasses and the bad, and of notorious weeds and parasites. Yet whilst the school wall is adorned with pictures of the tiger and the elephant of the Indian jungle, there are none showing the metamorphosis of a click beetle, or the structure of a grass. The boy may be taught to draw a map of the unstable frontiers of the south-east of Europe, which are hundreds of miles away, but he is never taught to seek out the ergot which infests the grasses, or to destroy the chrysalids which hang upon the hedgerows, or to recognise the plants of the meadow close to his cottage door. Knowledge such as this might become of much use to him, and render him a valuable and desirable farm-servant in after years; but it is kept from him, and he grows up stolid and indolent, because during the most impressionable years of his life our system of education fails to interest and instruct him in matters which will be of the greatest practical importance to him, and most intimately associated with his future labours."

My own experience is, that progress is checked by the stolid opposition of labourers to the introduction of anything out of their usual beat, whether in the employment of new implements, the introducing new methods of feeding animals, improved processes in hay-making, and in many other ways. Good practical instruction at the village school might, perhaps, encourage a more enlightened state of mind upon these subjects.

Enterprise (Private and Corporate Efforts).

The paternal principle of government has never found favour in England. Almost everything in the way of advancement is left to private and corporate enterprise, and the results of this system of self-help have been magnificent. I have no wish to travel beyond my text, and shall therefore stick to agriculture. English agriculture is the envy of the world. It is true it has passed through a severe and protracted trial, owing to the fall of prices, and several years of unproductive seasons. It, however, already shows unmistakeable signs of improvement. Landlords and farmers have learnt much during these bad years—more than any college course could teach them. They have modified their mode of cropping, increased their dairies, increased their cattle, laid land down to permanent pasture, taken to dairying, seed growing, cabbage, kale, potatoes, fruit, and other neglected modes of raising a revenue from land. They have learnt to save straw, to compound their feeding stuffs. They sow improved stocks of seed, and reject inferior animals. They save labour, have adopted improved methods in the dairy, and have wonderfully improved both their butter and their cheese. The milk trade in London and other great towns has proved of great value to them. We have got down to a safe bottom with reference to prices, and we may at least reckon on steadiness, and hope for advancement. The cost of entering upon farming business has been much lowered; rents and labour have come down. A saving

is effected on each of the following numerous items: — Rent, tithe, labour, seed, horse corn, feeding stuffs, manures, implements, purchased cattle, sheep, pigs, and horses. These savings amount to from 30 to 40 per cent. in almost every case, and go far to balance the fall in prices of commodities sold. Farmers who take land judiciously now, do so with a fair prospect of eventual success, and upon a much sounder basis than it could have been taken twenty years ago. The position of farmers who are saddled with long leases dating from better times, those who rent from obdurate landlords, and those who have borrowed money, is bad; but I fail to see that the skilled farmer who possesses capital, and is free to make a fair bargain with his landlord, is in a bad position. Dairy farmers, the men who above all others it appears are singled out for assistance, are exceptionally fortunate. No class of men have progressed more rapidly with the times. They have wiped out the obloquy of a few years ago with regard to the alleged inferiority of their butter and cheese; and these English productions are once more equal, if not superior, to those imported from Denmark, Brittany, and Normandy. A great deal of our Brittany and Normandy butter comes from Ireland, and much is made in London.* The system of travelling teachers, passing from dairy to dairy, explaining and demonstrating improved processes has borne excellent fruit, and the dairy exhibitions held in connection with the great agricultural shows have also been a most potent means of improvement. Dairy schools have also sprung up during the last four years in connection with factories, and if they are allowed the opportunity for development they will add to our other means of improvement. There is an excellent school of this nature in Cheshire, presided over by Miss Connell, who was trained in the Munster Dairy School, near Cork. Lord Vernon's butter factory and creamery at Sudbury, in the county of Derby, was made available as a dairy school in 1883. I cannot speak of the success of this institution, as pupils have not taken advantage of its undoubted merits. Mr. H. F. Moore writes as follows:—"I do not think there is the slightest doubt but that during the past twenty years there has been a great improvement in the average of the dairy productions of the United Kingdom brought about by the pressure of foreign competition. Best qualities of butter and cheese are much more widely made. The markets have compelled this, as a ready market can only be found for cheese of a value of over 65s. or 68s. The result has been that the quality of what was before lower quality cheese has improved very much. Two years ago I estimated that since the Frome Show was established in 1870, the increase in value had put quite a million sterling into the pockets of the cheese makers of the Cheddar district. Mr. Howard estimates that the annual value of the cheese made in the United Kingdom is £6,955,666, and on these figures I should say that at least £350,000 annually (or a little over 5 per cent.) represents value for improved quality as compared with ten or twelve years ago." Similarly Mr. James Howard values the butter produced at £10,744,496, and the improvement in value of butter owing to improved processes Mr. Moore puts at £500,000 per annum. The improvement in the production of milk owing to better bred and better selected cows is probably 480 gallons per annum per cow, instead of 440 gallons per cow in 1866; "but if we put down the increase at half this, or 5 per cent., we have 27,750,000 more gallons of milk, or, at Mr. Howard's value of 8d. per gallon, a money value of £925,000 per annum." The Dairy Farmers' Association and the Annual Dairy Show; the much greater attention given to dairying in the agricultural Press; the employment of travelling instructors and the addition of well equipped dairies to existing agricultural colleges—all show that private enterprise is ably supplying what was needed in the matter of dairy instruction.

* The rage for a uniform quality of butter has exerted an injurious effect upon brands of especially good quality. These are mixed with medium and inferior butters, manufactured, and probably, in many cases, mixed with margarine, and sold as butter of uniform character. The public taste has by this means become to a certain extent vitiated.

State Aid.

There is much to be said in favour of State aid. It secures pecuniary assistance without trouble. It is comfortable, safe, and the grant is paid regularly. It secures appointments for hard-working and deserving people. It demands no extra exertion beyond the stipulated duty. It usually affords remuneration irrespective of success or of failure. It is obtained from the very deep pocket of the imperturbable and somewhat phlegmatic British public. But, State aid has also some drawbacks. If not carefully bestowed it may give opportunities for patronage, for place and pay, for wire-pulling and intrigue, it increases the public burdens, and extends the evils which are

inseparable from officialism. State aid is granted, we know, in education, in science and art, and in a variety of ways. The point before us is that of the application of

State Aid to Agricultural Education.

To a very limited extent State aid is already thus granted to agriculture. The Agricultural Chair of Edinburgh is subsidised. There is a Chair of Agriculture at South Kensington, and agriculture is included in the scheme of the Council on Education, as Subject XXIV. The amount granted to agriculture must be very considerable, taking into account the expenses of the May Examinations, and the payment by results made to teachers. Agriculture is also included, as has already been mentioned, in the standard for elementary education in Board schools, although the facilities thus offered do not appear to be widely utilised.

Early in September, it was announced that a Departmental Commission of the Privy Council was appointed "for the purpose of inquiring into and reporting upon agricultural and dairy schools in Great Britain which may properly receive Government grants, and to advise as to the department which should be charged with the administration of such grants." This commission is now generally known as Sir Richard Paget's commission. Since Parliament has met we have received the additional information that a Department of Agriculture is to be formed, or rather developed and extended; and further, that some of the recommendations of Sir Richard Paget's Committee are to be adopted. Also, we have been informed that £5,000 a year, at least, is to be devoted to these objects. We are, therefore, distinctly moving forward; something is really going to be done. The latest note which has come under my observation is a sheet issued by the Agricultural Department, as it at present exists, headed:—" Agri. $\frac{5}{1888}$. Agricultural Education in Wurttemburg," describing the system there followed.

Time will not allow of my following the various suggestions made by Sir Richard Paget's Committee. They have been criticised freely in the London daily papers, and the English and Scotch agricultural journals.

I will quote those which appear to me to be of the greatest value. At Clause 7, the committee recommended "that increasing facilities should be given for the study of the principles of agriculture in rural elementary schools, and that gardens, allotments, and farms, in connection with them, should be encouraged." This is the keynote which ought, I submit, to be that of the coming symphony.

The vaster machinery of a proposed Normal School of Agriculture—including forestry, dairying, gardening, fruit-growing, poultry and bee-keeping, to be fully equipped with land, buildings, and staff, at the expense of the State—has raised a considerable amount of criticism. The recommendation that the "diplomas from this school should be granted only in recognition of the very highest qualification" marks the suggestion at once as covering the field now occupied by existing colleges. This monopolising of the field of higher agricultural education it is attempted to provide against, by the further recommendation that "care should be taken that the school should not enter into competition with the already-established colleges of Cirencester, Downton, &c." This is a very considerate, but most impracticable recommendation. It is impossible that a State-aided college, equipped as suggested, granting diplomas such as are indicated—available to students for fees of £40 to £50 per annum—could be anything else than a rival of existing colleges, and for reasons which may be conveniently quoted from the columns of the *North British Agriculturist* for February 1st.

A correspondent writes as follows:—"I maintain that the immediate effect of the endowment and equipment of such a school would be a transference of patronage from existing agricultural colleges, and that for these reasons:—The Government school would carry an unavoidable prestige, it would be, or ought to be, equally well equipped, and it would be cheap. It would draw students from Cirencester, and Downton, and Edinburgh. It would be filled by the sons of gentlemen, and the farmers' and dairymen's sons would not appear. The scheme would at once be perverted from its original intention, and it would strangle all private enterprise, and monopolise the agricultural teaching of the country." Another correspondent of the same paper points out that "if this college were successfully established, the present agricultural course in Edinburgh would be greatly curtailed, and it would be impossible for the lectures in agricultural chemistry, botany, and veterinary science to be continued." These opinions are endorsed by the leading article in the same representative agricultural paper—the *North British Agriculturist*.

The *Times*, of the 21st ult., in a leading article upon this proposal, spoke as follows :—"The further recommendations of the committee respecting the creation of a Central Government School, chiefly for instruction in dairy work, are open to serious criticism. They seem to ignore what has already been done by voluntary and non-official effort, for the promotion of agricultural education, and their effect might easily be to destroy or impair the efficiency of institutions, like the colleges at Cirencester and Downton, without putting anything equally valuable in their place. In fact, what seems to be really needed, is not so much the establishment of a new department of agriculture, with large functions and ambitious aims, as the consolidation and co-ordination of existing agencies for the spread of agricultural education, and of systematic instruction in the theory and practice of farming operations. . . . . . The State can do little in such matters, and perhaps the less it directly undertakes the better."

The following note of warning, from France, is also worth recording. I take it from the columns of the *Agricultural Gazette*, of February 13th. "I hope," writes this French correspondent, "you will try to stop the Government from creating such a 'bottomless well' as an official Government school. Here the Government gives tens of thousands of pounds a-year for agricultural education and schools, and the director of one of the most important says it is miserably insufficient, and that next to nothing is done by it. For his institute alone, unless he could get £4,000 a-year for the next few years, he could not even provide proper buildings. He bitterly lamented that in France, where this education is granted free, the people care nothing about it. He further was very strong on the point that practical agriculture cannot be taught in schools, but only from actual practice. The management of labour and the management of farm finances were two matters, he contended, of which each was quite equal to a knowledge of the principle of practice. They were more, for on them really depended success or failure. Neither could they be taught; they came partly by intuition, mostly from actual practice. Government subsidy and endowment he declared to be a 'bottomless well,' in which enough money was never thrown, with results, meanwhile, never satisfactory or complete." The truth of these assertions I shall illustrate further on.

State-aided Agricultural Education in other Countries.

Information upon the vast array of agricultural colleges in Germany, France, Belgium, Denmark, the United States, and Canada, is open to all students of this question. To even name these colleges and schools would extend the limits of this paper to an undue degree. I shall not attempt so much, or so little; I shall, however, point out distinctly why they are in some measure supported, and where they fail. The conditions of their success certainly do not exist in this country, while the reasons of their failure exist in this country to an exaggerated degree. I speak deliberately, and after careful study of the subject, when I say that in England they would prove a disastrous failure.

Why Agricultural Colleges receive Support in Germany and France (the One Year's Military Service).

"The pivot," wrote the late Mr. Jenkins, in 1884, "upon which the German system of higher education turns, is the qualification for one year's voluntary service in the army. Almost every student at the universities is possessed of this right; and the chief object of the higher agricultural schools is to enable the sons of farmers to qualify for the right at the same time as they are acquiring knowledge which may be useful to them hereafter, in the cultivation of their estates or farms. Thus the two higher grades of agricultural educational institutions have distinct and definite relations to the one year's military service" (Report of Royal Commission on Technical Instruction). At Hildesheim, many of the pupils enter the school for the purpose of acquiring the one year's *voluntariat*, in preference to obtaining the same right at a gymnasium. Herr Matzat says, "I think it useful to remark that the right to the one year's voluntary army service is most particularly the *punctum saliens* of high-class education in Germany. Thus it happens now that no high school flourishes if its final certificate does not carry this right." Dr. Dunkelberg, of Bonn (Poppelsdorf), speaking of intermediate agricultural schools, says, "The object of these schools is to educate youths up to 17 or 18 years of age in mathematics, natural sciences, and two foreign languages, to such an extent that they can obtain the right to perform their military duties in one year." Turning to France, we find

precisely the same state of things, but still more accentuated. Mr. Jenkins, in his capacity of Assistant-Commissioner, thus expressed himself:—"The right to one year's voluntary service in the army without further examination is attached to the entrance certificate of the higher schools, and to the final certificate of the lower schools, namely, 'practical schools of agriculture' and 'farm schools.' The importance of this privilege to the pupils of the lower schools is very great, because, instead of spending five years in the army it enables them to devote two of their years to acquiring technical instruction in their future business, either without payment or by paying a portion of their board and lodging. Compulsory military service is a point which requires to be constantly borne in mind when it is attempted to estimate the adaptability of the French or German systems of agricultural education to our circumstances." Were it not for this much-desired privilege—which, it must be remembered, also lifts its recipient into the grade from which officers are drawn—agricultural education in Germany would scarcely continue to exist.

They are Exceedingly Cheap, or Free.

In Württemberg, the State of all others which is held up as an example, the lower agricultural schools "do not differ much in their plan or organisation from some of the other parts of Germany except in this, that the pupils have nothing to pay for their board, lodging, and instruction for three years" (Royal Commission on Technical Instruction, p. 20, part II). At Hohenheim, students who are natives of Württemberg pay £9 per annum for instruction and lodging, and they pay for their own food at a restaurant, which entails an extra cost of 2s. a day. In the intermediate schools the fees are from £2 to £4 per annum, and the entire cost to the student is estimated at £25 a year (*ibid*, p. 49).

In the magnificent high school at Berlin, which, exclusive of the land, cost the State £126,000 at the very least, the fees for ordinary and extraordinary students is £5 per half-year; entrance fee 10s. Practical chemistry, £1 per half-year; agricultural chemistry, 10s. per half-year. It is needless to insist upon the cheapness of university and college training in Germany. The point is rather with regard to the extremely low cost, and even absolute freedom from cost, in schools of an intermediate and lower character for the benefit of farmers, peasants, and bailiffs. At Riesenrodt (Westphalia) the full payment of the pupils is annually £20 for board, lodging, light, and instruction, and £23 for students who do not work on the farm. The first-mentioned payment is reduced to £12 10s. in the "case of the sons of poor peasant proprietors" (p. 55). And yet of late years there has been such a decrease of pupils (p. 70), that the director, Mr. Gorker, says that if this tendency continues, the theoretico-practical farming schools cannot long be maintained.

With respect to the intermediate agricultural eduation in France, the Minister of Agriculture wrote, on August 12, 1875, to the préfets:—"Admission to the practical schools will not be entirely gratuitous, but the payment (grant) to be made will always be calculated in a manner to represent as exactly as possible the cost of the food and maintenance of the pupils." At St. Rémy, ordinary students pay £1 per month. At Ecully, pupils pay £18 per annum, and £2 per annum if non-resident. At Tomblaine, the pupils pay £24 per annum. There were, in 1882, 18 students, and 15 professors and teachers! As to the lower agricultural education, intended for labourers and small farmers (farm schools), "if any kind of payment were enforced, it would be impossible to obtain pupils for the school. All they have to do is to bring a certain wardrobe with them. Further, the apprentices, as this class of students is termed, acquire, at the conclusion of their term of two or three years, the right of one year's voluntary service in the army, and a present of £12 to £24, according to the length of their apprenticeship, this amount being supposed to represent what they might have saved out of their wages during that time, if they had been paid as indoor farm-servants." Nevertheless, with these extraordinary advantages, the number of these schools has diminished, and is diminishing rapidly.

La Pilletière, in the Sarthe, is an excellent example of these farm schools, and the apprentices (students) are the sons of small proprietors and tenants in the neighbourhood. After ten years' experience, the director says:—"Notwithstanding all the advantages given by the Government to the young men who become apprentices at the farm schools, the sons of farmers cannot be tempted to pass two or three years at one of them. For my part I find the greatest difficulty in obtaining ten new apprentices per annum, and I am obliged, in order to fill up the vacancies, to accept the sons of persons who are strangers to agri-

culture." The director says further:—"The number of farm schools has diminished from 70 to 22, and its tendency is to decrease still more." I think these statements bear out the opinions of the French correspondent of the *Agricultural Gazette*, before quoted.

Official and Private Openings for Students.

One powerful influence brought to bear upon agricultural education in Germany consists in the opportunities it affords for a career. Professor Kühn, director of the Agricultural Institute at Halle, writes as follows:—"The administrators of the State domains of Prussia and Brunswick give the preference to those agriculturists who, in addition to their practical capability, possess scientific knowledge, obtained by studying at one of the agricultural institutes. A very large number become professors at agricultural colleges, directors of the different grades of agricultural schools, and teachers of agriculture in high schools, as well as travelling teachers in some of the provinces." (Abridged quotation.)

Professor Wohltmann, of the same institution, who visited me last November, informed me that many landowners insisted upon their agents and bailiffs being qualified with a certificate or diploma from an agricultural college. Prussian land surveyors must pass a State examination in order to be able to practice as professional men, or to give evidence legally before a Court.

When we take all these considerations together, the wonder is that much larger numbers of young men do not take advantage of the splendid opportunities offered. The extreme difficulty of finding pupils for these schools, when the motives for attendance are so strong, is in itself a proof that in England, where no such collateral advantages are offered, the farmers would not support such a school or schools. It is well known that Cirencester tried the experiment by opening with a tariff of charges well within the means of farmers. It was, however, soon found that the farmers would not support it. At Downton we have had a similar experience.

Denmark.

Although in Denmark the lower schools of agriculture all receive a subvention from the State, they are not Government schools. They have generally been established by means of charitable bequests, and sometimes by means of subscriptions from landlords. The peculiarity of the Danish system is the complete separation of practical from theoretical instruction, and that, consequently, 'farm schools' and practical schools of agriculture, in the sense in which the terms are understood in France, and by some persons in England, never have succeeded. I beg leave to pass by the Royal Agricultural College at Copenhagen and the other high-class colleges without particular notice, as no proof is needed as to the utility of institutions provided for the higher agricultural education.

General Remarks upon Agricultural Education in Germany and France.

In these countries it is clear that, with the powerful levers of exemption from military service, and a grand curriculum of instruction enjoyed at nominal cost or entirely free, or even better than free, the farmer will not avail himself of them. I would add that in Germany there is a special demand for bailiffs so educated, and yet, in spite of all this, the pupils fall off in numbers.

I must also draw attention to the fact that in these countries vine cultivation alone must be very well worth thorough study, and that German or French agriculture must require more systematic instruction than is required by the English farmer. Here, in England, it might fairly be pleaded that corn, grass, and turnips are simple plants, requiring for their successful cultivation no very special training at a college. I say that it might be so held. But in these countries the products of the soil are more diversified, and all in the direction of special manipulation. Besides the vine, there is tobacco, flax, hemp, fruit, and, above all, sugar beet, and the sugar industry. These crops alone seem to absolutely require long training in those who desire to manage them satisfactorily, and therefore the failure to draw pupils (which failure also attaches in some degree to the higher agricultural colleges) is most extraordinary and unaccountable. If such is the case in the green tree, what must it be in the dry? Can we think for a moment that the English farmer is to be tempted out of his quiet routine with such a bait?

America and Canada.

We now turn to America, where a prodigious effort has been made to establish agricultural education on a grand permanent footing. For agricultural and mechanical colleges 9,000,000 acres of land have been set

aside for purposes of endowment, as well as cultivation and experiment. Besides, the endowment of magnificent educational establishments has been effected in several cases by private benevolence, as for example the Johns Hopkins University, Baltimore, founded on a bequest of £700,000 made by Johns Hopkins; the Cornell University, endowed by large donations and the benefactions of Ezra Cornell; the Bussey Institution, endowed by the founder with £3,000 a year; the Girard College, endowed by Stephen Girard; the Rensselaer Institution, endowed by Stephen Van Rensselaer, &c. There are forty-nine State colleges for mining, engineering, and agriculture, and for other objects endowed by the national grant for 1880 alone. Taking, however, the entire facilities offered by previous public and private endowment and enterprise, we may almost stand aghast at the number of 364 universities and colleges provided for a gross population of 50,000,000, of which 7,670,000 are engaged in agriculture, or one university or college for every 137,362 of the entire population. This does not include public schools, elementary and high, which exist to the number of nearly 230,000. Confining our attention to the agricultural colleges and experimental stations of the United States, there is no doubt that the result must be considered as wofully disappointing if looked at from the point of view held by some persons in this country, who would like to see similar institutions multiplied by State aid. Take, as one example, the Agricultural and Mechanical College of Alabama, near Auburn, with an endowment fund of 253,500 dollars, and a revenue of 22,500 dollars. Practical agriculture is taught in all its branches. The students in the mechanical and scientific departments greatly outnumber those pursuing agriculture (Agricultural Report, Dominion of Canada, 1885, p. 1885); and yet in this State 72,000 persons are engaged in agriculture, and only 22,000 are engaged in mechanical, manufacturing, and mining. In the University of California, splendidly endowed for practical and theoretical instruction in agriculture, only seventeen out of 247 were taking agriculture in 1885. In the splendidly equipped University of Illinois, between Champagne and Urbana, where the expenses amount to 60,000 to 70,000 dollars per annum, out of a total number of 356 students, only 21 were in 1884 preparing for agricultural pursuits! In the Purdue University, near Lafayette, where the school of agriculture forms one of the most important departments, and is fitted with special buildings, experimental farm, and laboratories, with a State subvention to meet deficits of a revenue of 22,235 dollars, the students in agriculture do not exceed 6 per cent. of the whole number receiving instruction! The comment in the Report of the Minister of Agriculture for Canada, already quoted, is as follows:—"The same complaint is made here as elsewhere that, notwithstanding all the facilities offered for obtaining a thorough agricultural training, very few farmers care to give their sons the benefit of it" (p. 224). At Iowa State Agricultural College, out of 300 students only 30 are at present taking the agricultural course! (p. 225). At the New York State College of Agriculture, with an income of 130,000 dollars and a farm of 120 acres, of 400 students attending—and where so many advantages are offered to those desiring to study agriculture—the agricultural class seldom exceeds in number from 20 to 25! (p. 247). At the State Agricultural College of Wisconsin, with an endowment of 498,000 dollars, and a revenue of 83,000 dollars, there are 400 students, "but very few are availing themselves of the privileges offered in the line of agricultural education," (p. 257). And this is the result of an annual expenditure by the State, for the purposes of agricultural education, of 408,810 dollars, or upwards of £80,000!

Canada.

In Canada we have a repetition of the same repugnance on the part of farmers to attend the instruction offered in agricultural colleges. The Ontario Agricultural College is the only institution of the kind in Canada. The expenses of this college in excess of its revenue have been as follows:—1881, 28,464 dollars; 1882, 35,697 dollars; 1883, 43,404 dollars; 1884, 37,779 dollars. This points to an average expense, *beyond revenue*, of 36,335 dollars, or of £80 per student on 90 students.

General Conclusions as to State-aided Agricultural Education.

Summarising the results of experience gained in various countries, it is evident that any attempt on the part of the State to create a demand for technical instruction on the part of farmers, has met with very partial success. What small success it has met with in France and Germany, appears to be due, to (1) the exemption from military service; (2) the extreme cheapness of State-aided instruction,

en amounting to State maintenance; (3) ɜ large number of openings for students, ·ing to the prevalence of officialism; (4) the ıch greater complexity of their system of ltivation, including the growth of wine, gar, tobacco, flax, hemp, &c., all of ıich require more explanation and elucida-ɲn than do the processes of English agricul-re. Their agriculture, like their grammar, quires study. The farmer does not, and will ıt, appreciate the value of scientific training, ıd the experience of agricultural colleges in l countries ought to be entirely convincing of e truthfulness of this general statement. I ıght to have pointed out another feature importance, which belongs to all the ɲntinental agricultural colleges, school rms, and farm schools, namely, that they ford excellent instruction in modern lan-uages, history, and general education: so ıat they are not merely technical schools, ıt seminaries devoted to ordinary educa-on.

Neither must we forget that all the State-ided agricultural schools form a part of a ystem of protection and artificial fostering of ıdustries. Take, for example, the sugar ıdustry in Germany and France, bolstered up y bounties and, among other things, by State-ided instruction in a rotten industry. The ame objection may be urged against technical ıstruction in many mechanical arts in America, vhich only exist by virtue of protective duties, nd which are artificial from beginning o end. Let any impartial person study ir T. H. Farrer's book on "Free Trade *ersus* Fair Trade," and he will come away onvinced that the material progress of this ountry has outrivalled that of any of he protecting countries with all their boun-ies, duties, and State-aided technical in-truction.

Finally, I protest against the founding of State-aided agricultural colleges, for reasons given in the earlier sections of this paper. I protest against hunters for place and for pay. I claim some credit for Cirencester, for Down-ton, for Aspatria, Hollesley Bay, Hole-park, and for all other independent efforts to meet the very languid demand which no doubt exists for sound agricultural information. Let the subject be ventilated, and let the ideas spread through this wealthy, intelligent, free, and unfettered country. Nay, further, if a Government grant is to be given, let it aid existing efforts without greatly controlling them. Let it follow out the instructions given to Sir Richard Paget's Commission, namely, to "inquire and report upon agricultural and dairy schools in Great Britain which may properly receive Government grants." Let scholarships be given, that young men of talent may take advantage of existing means of instruction, or of those means of instruction which are speedily arising, and will continue to arise, if not throttled by an overshadowing State-aided system, fettered by officialism, and a prey to place-hunters. Neither let us too hastily conclude that agriculture requires such aid. The cloud is lifting. Although we have passed through times of extreme pressure, we seem at last to have touched bottom, and the man who thinks of investing money in land, or in farming, can do so at the present moment with a better expectation of commercial success than he could have entertained at any time during the last twelve years. I do not deny that agricultural education has had much to do with this happy result; but it is not solely the education of the young nor the instruction of the professor or schoolmaster. It is the education which comes from conflict, the education which comes through the printing press, the instruction which flows from our agricultural literature and agricultural exhibitions; and I devoutly hope that this free course of knowledge and of enterprise will continue to be allowed to flow on without State patronage, and in harmony with the independent and courageous instincts of the British nation.

DISCUSSION.

Mr. Wm. Botly thought the paper a good supplement to that read by a professor from Downton College before the British Association at Manchester last year, and he cordially agreed with the remarks respecting State education. One subject which ought to have more attention paid to it than it received was that of cottages and gardens for labourers, and he believed if landed proprietors some sixty years ago had attended to the principles laid down, that every farmer should have a sufficient number of cottages with gardens to them, labourers would have become attached to the soil instead of having been driven away.

Mr. S. B. L. Druce said he had two subjects of regret, first, that no member of the Departmental Commission presided over by Sir Richard Paget was present that evening; and secondly, that at the present time, when they had had a definite promise of a grant

principal, he had no hopes that the school could teach practical agriculture. It was said they had no one in England who could teach dairy work; but he knew that last September a cheese-maker from the Cheddar district was engaged to manage a factory in Scotland at a salary of between £250 and £300. The fact was it was merely a question of money; if a proper price were paid there would be no difficulty in finding in England the very best cheesemakers. He looked upon the proposal to found a Normal School as one of the most mischievous things that could be imagined.

Professor WRIGHTSON, in reply, said he was sorry to find that Mr. Druce had anything to regret, especially the running down of State aid. He did not wish to deprecate entirely the idea of State aid, and if the paper were studied it would be seen that he stated he should like to see State aid directed towards the lower strata of agricultural education—that is the increase of tuition in Board schools. No doubt one reason why greater use was not made of the facilities already afforded was because they were included in Schedule II., and doubtless the greater part of the children left school before Schedule II. was reached. Mr. T. Wilkinson, head master of the Harrow Board School, in his suggested syllabus, had transferred the whole of the agricultural teaching in Schedule II. to Schedule I., with a view of getting it more practically used. He agreed that Cirencester and Downton Colleges were not in need of direct State assistance; but without asking for State aid, it had occurred to him that scholarships might be held at such colleges of from £60 to £80 a year, which would reduce the fees, and thus make them available for the sons of farmers. If twelve scholarships of this amount were offered throughout England for farmers' sons, it would amply meet the case, and the probability was that all the scholarships would not be taken up. With regard to the foreign demand for education, the cases to which he had referred were not picked cases; there was the greatest difficulty to get pupils, and the convincing proof was that the number of schools for the education of peasants had decreased in Germany, while in France the number had dropped from seventy to twenty-two. As to the observation that men would be superior to the masters if taught science subjects, that was a matter which might readily be altered. He did not wish to advocate any system of instruction for labourers which would be unnecessarily complicated or abstruse, but at the same time the education given should be of the very best.

On the motion of the CHAIRMAN, a hearty vote of thanks was passed to the reader of the paper, and the meeting adjourned.

Miscellaneous.

BASIC OR THOMAS-GILCHRIST PROCE[SS] IN 1886-87.

The total make of steel and ingot iron fr[om] phosphoric pig during the twelve months end[ing] 31st October, 1887, amounts to 1,702,252 t[ons], being an increase over the make for the previ[ous] twelve months of about 388,621 tons. Of this m[ake] no fewer than 1,222,732 tons were ingot iron, co[n]taining under 17 per cent. of carbon. The make[s of] the various countries for the twelve months end[ing] 31st October, 1886, and 31st October, 1887, respe[ct]ively, are as follows:—

—	1886.		1887.	
	Total tons.	With under 17 per cent. carbon.	Total tons.	With under 17 per cent.
England	258,466	161,908	364,526	233,3
Germany, Luxemburg, & Austria	883,859	651,523	1,102,496	826,6
France..............	122,711	77,141	174,271	123,0
Belgium and other countries	48,595	36,712	60,959	39,7
Totals	1,313,631	927,284	1,702,252	1,222,7

WATTLE TREE CULTIVATION IN NE[W] ZEALAND.

Consul Campbell, of Auckland, says that the watt[le] tree is a native of South Australia, but grows exte[n]sively in New Zealand and in the Australasi[an] countries. It belongs to the acacia family, a[nd] grows readily in almost any kind of soil in which [it] has been tested. Its growth, however, is more rap[id] in sandy places. The greatest value of the tree is i[ts] bark, which always commands a good price f[or] tanning purposes, but the wood of the tree can b[e] utilised for barrel and cask staves, waggon an[d] plough timber, axe and pick handles, and many othe[r] articles requiring tough, hard, and durable woo[d]. The gum which exudes from the tree is also of value, always commanding a good price, and its collectio[n] does not affect the bark or injure the tree. The les[s] gum there is left in the bark the more valuable i[t] becomes. There are several descriptions of th[e] wattle tree growing in New Zealand, but the bes[t] are the black or feather leaf (*Acacia decurrens*), an[d]

golden or broad leaf (*Acacia pycnantha*). The ... of the wattle is said to yield a larger per-centage ...annin than any other tree grown in the colony, ... it is stated that tanners who have tried both the ...tle and the oak tree have given the preference ... the former. Its cultivation is looked upon ... one of the most profitable industries, and ... question of allowing a bonus, as an induce...t to persons to engage in planting the tree, is ...g agitated in the agricultural papers of New ...land. The bark of the wattle is stripped off the ...s in the season of the year when the sap is most ...ve, and, in order to keep up the supply, the ...ting is done annually, thus replacing the trees ... have been killed by taking off the bark. Plant... can take place with the early showers of autumn ...pring, and as the outer covering of the seed is ...uliarly tough, rendering it impervious to ordinary ...minating influences, it requires, before sowing, ...e soaked in hot water until it becomes soft. As ... seeds are small, and require to be kept near the ...ace, a very slight sprinkling of earth over them ...ufficient. The ground is generally ploughed very ...ply, well harrowed and rolled, and the rows laid ...ut five feet apart. At the end of about seven ...ths the wattle attains a height of about three ..., and, in one district in New Zealand, Consul ...npbell says that trees of seven years' growth ...ined the height of forty feet, and three feet in ...umference, yielding three hundred pounds of bark ...he tree.

Correspondence.

SCIENCE AND ART DEPARTMENT.

...Major-General Donnelly's letter of March 5th ...uires to be supplemented by a not unimportant ... to which he makes no reference, namely, that I ... a personal interview with one of his own official ...f on the very point on which, according to ...neral Donnelly, "the Department had no reason ...suppose," &c. As a further aud significant fact ... it noted that whilst General Donnelly *now* gives ... reason for declining, in 1875, my application to ...rk in the chemical instead of the biological ...oratory, that the number of studentships being ...d "by the capacity of the school," those in ...mistry were "full;" an explanation which must ... taken for what it is worth by the light of the very ...t statement that I "then joined the school as a ...paying student," and I entered the department ...chemistry!

...As to the scholarship awarded to me being a ...tudentship" or a "teachership-in-training," I ...e tha... General Donnelly now contends that this ...s not a "scholarship of any kind." At that date I certainly regarded "free instruction and an allowance"—worth in total some £80 or so—as a very valuable scholarship.

SILVANUS P. THOMPSON.

20, Arundel-gardens, W.,
March 12th, 1888.

General Notes.

HERKOMER SCHOOL.—The annual general meeting of the Herkomer School (established 1883, incorporated 1887) was held at Bushey on the 13th January last, when the first annual report of the Council was presented. The President (Professor Herkomer) delivered an address to the members and students of the school on the work of the past year.

GAS-HEATING APPLIANCES.—At the meeting of the Liverpool section of the Society of Chemical Industry, on Wednesday, March 7th, Mr. Thomas Fletcher, F.C.S., gas engineer, of Warrington, gave a demonstration of the application of some new gas-heating appliances, devised by himself for workshop emergencies, when he fused a large hole in a plate of $\frac{1}{4}$-inch thick wrought iron in a few seconds, without preparation, and with apparatus which could be carried by a man up a ladder, and used in any position. The Secretary, in the discussion which followed the experiments, raised the point that with such apparatus as Mr. Fletcher had exhibited and used, a burglar-proof safe no longer existed, as it was simply a question of minutes to fuse a hole large enough for a man to enter in any wrought iron or steel door in existence. Chilled iron or steel were powerless to resist the small blowpipe Mr. Fletcher used, which would penetrate thick iron and steel plates as readily as ordinary carpenters' tools would penetrate wooden doors. The apparatus was devised by Mr. Fletcher for works repairs, and was noisy in action; but, as he explained, the apparatus could be made silent, and small enough to carry in a hand-bag Mr. Fletcher subsequently explained that the present danger is possibly not so great as it appears, owing to the fact that the apparatus necessary to manufacture and prepare the silent arrangement is both costly and large, and as the person who prepares it must have fixed machinery and plant, he will most probably be one of the last to whom the enterprising burglar would apply for his apparatus.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 21.—"The Evils of Canal Irrigation in India, and their Prevention." By T. H. THORNTON, C.S.I., D.C.L. Colonel Sir OWEN T. BURNE, K.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MARCH 20.—"What Style of Architecture should we follow?" By WILLIAM SIMPSON. Prof. T. HAYTER LEWIS will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock :—

MARCH 27.—"The Panama Canal." By J. STEPHEN JEANS.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

MARCH 16.—"The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D. Sir WILLIAM W. HUNTER, K.C.S.I., LL.D., will preside.

CANTOR LECTURES.

The Fourth Course is on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

LECTURE II.—MARCH 19.—Influence of varying quantities of metals on each other.—Exceptional effects of "traces" of impurity.—Certain physical constants of alloys.—Evidence as to allotropic states of their constituent metals.

DR. MANN LECTURES.

The second lecture will be delivered on the "Protection of Buildings from Lightning," by Prof. OLIVER J. LODGE, D.SC., F.R.S., on Saturday afternoon, March 17th, at 3 o'clock.

LECTURE II.—Experimental answers to some of the questions raised, and a more complete theory of the liability of conductors to side-flash than has yet been given.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys" (Lecture II.)
Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. Dundas Gardiner, "Points in the Law relating to Ancient Lights."
Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Prof. Tristram.

TUESDAY, MARCH 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. William Simpson, "What Style of Architecture should we follow?"
Royal Institution, Albemarle-street, W., 3 p.m. Dr. G. J. Romanes, "Before and After Darwin." (Lecture X.)
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. P. W. Willans's paper, "Economy Trials of a Non-Condensing Steam-Engine—Simple, Compound, and Triple."
Statistical, School of Mines, Jermyn-street, S.W., p.m.
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "Notes on the Classification of the Ranidæ." 2. Mr. G. R. Sowerby, "Descriptions of Sixteen new Species of Shells." 3. Mr. Frank E. Beddard, "Observations upon a Worm of the Genus *Æolosoma*."
Meteorological 25, Great George-street, S.W., p.m. Exhibition of Apparatus connected with Atmospheric Electricity.

WEDNESDAY, MARCH 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. H. Thornton, "The Evils of Canal Irriganion, and their Prevention."
Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), Noon. Annual meeting. 1. President's Address. 2. Reading of papers and discussion.
Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Mr. I. Foulkes, "Talhaiarn."
Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Spring Exhibition.
Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. Mr. G. G. M. Hardingham, "The Proposed Patent-law in Switzerland."
United Service Institute, Whitehall-yard, S.W., 3 p.m. Major E. A. de Cosson, "Land and Water Transport in the Soudan and on the Nile."

THURSDAY, MARCH 22...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), Noon. Morning meeting. 7 p.m. Evening meeting. Reading and discussion of papers continued.
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Mr. A. S. Murray, "Physical Training of the Greeks and Romans."
Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. H. Dallinger, "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life." (Lecture III.)
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Professors A. W. Rücker and C. V. Boys, "Electrical Stress."

FRIDAY, MARCH 23...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), Noon. Morning meeting. 7 p.m. Evening meeting. Reading and Discussion of papers.
United Service Inst., Whitehall-yard, 3 p.m. Admiral R. H. Colomb, "Naval Mobilisation."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting 9 p.m. Sir Frederick Bramwell, "A Lecture with—and without—point."
Civil Engineers, 25, Great George-street, S.W., 7½ p.m. Students' meeting. Mr. Henry W. Hodge, "Principal Types of American Swing-Bridges."
Quekett Microscopical Club, University College, 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
Browning, University College, W.C., 8 p.m. Mr. Kineton Parkes, "Parleyings with certain People."

SATURDAY, MARCH 24...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Modern Drama." (Lecture III.)

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FRIDAY, MARCH 23, 1888.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

RACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be eld by Mr. W. A. BARRETT, Mus. Doc. xon, at the House of the Society of Arts, nd will commence on Thursday, the 24th lay, 1888.

Full particulars can be obtained on applica- on to the Secretary.

BARCELONA EXHIBITION, 1888.

The Secretary of State for Foreign Affairs as communicated to the Society of Arts a lispatch from her Majesty's Ambassador at Madrid, reporting on the present state of the ntended Exhibition at Barcelona, in which ir Francis Clare-Ford refers to the condition f the Exhibition, and the rapid progress which is being made in the improvement of he city of Barcelona by the erection around he Exhibition of many fine buildings. Gardens re being laid out where before were unseemly ieces of waste ground. An aquarium is to e built on the sands; and commodious athing houses and tents are to be erected; ne of these is to be arranged for the especial se of the Queen-Regent. It is stated that here will be over 30,000 exhibitors, of whom nly 80 are English; 3,500 square yards are ssigned to the Barcelona Province alone, of which 3,000 have already been secured. The irst batch of goods for the Exhibition has rrived from Germany and Austria; and great fforts are being made to insure the success of he French portion of the Exhibition. In the gricultural pavilion a space of 800 square yards has been assigned for French agricultural products. The ambassador expresses the opinion that the date for the opening of the Exhibition will have to be postponed, as the arrangements cannot be completed much before the first week in May.

CANTOR LECTURES.

The second lecture of the course on "Alloys" was delivered by Professor CHANDLER ROBERTS-AUSTEN, F.R.S., on Monday evening, 19th inst.

The lectures will be printed in the *Journal* during the summer recess.

DR. MANN LECTURES.

The second and concluding lecture of this course on "Protection of Buildings from Lightning," by Professor OLIVER J. LODGE, D.Sc., F.R.S., was delivered on Saturday afternoon, 17th inst.

On the motion of the CHAIRMAN (Mr. W. H. Preece, F.R.S.), a vote of thanks to the lecturer was carried.

Proceedings of the Society.

INDIAN SECTION.

Friday, March 16, 1888; Sir WILLIAM W. HUNTER, K.C.S.I., LL.D., in the chair.

The paper was read—

THE ORIGIN, PROGRESS, AND INFLUENCE OF UNIVERSITIES IN INDIA.

By FREDERIC J. MOUAT, LL.D.Edin.

On the 4th of January, 1876, a Convocation of the University of Calcutta was held, to confer the honorary degree of Doctor of Laws upon H.R.H. the Prince of Wales, who was then travelling in India. This was the first degree of the kind ever conferred in that country, and needed the passing of a special Act of the Legislature in Calcutta, to legalise it. It is believed to have been due to the

initiative of Sir Joseph Fayrer, a distinguished member of the Senate of the university. It certainly marked an epoch, and an important one in the history of education in India, with which the heir to the throne of the greatest empire the world has ever seen, will now be for ever identified and associated.

When the news of this proceeding reached England, I happened to be assisting at a great public dinner in London. Next to me at the table was an eminent member of the English Bar, who was aware that I had been long in India, and connected with the public instruction of that country. He asked me what it all meant, as he had never even heard of universities in India. I explained to him, as far as I could on such an occasion, what I knew about it, and he was so interested in the matter, as to request me to send him a note on the subject. The substance of my note was expanded, and published in a periodical magazine of the time, but there was evidently then no public interest in the question.

Very recently, however, in a remarkable and admirable series of papers on the India of the Queen, written with singular elegance and force of diction, the question has again come to the surface. These have attracted considerable attention, and, in conversation with many who take a deep and abiding interest in the welfare of our Eastern Empire, I find that very little is still known of the history of the great movement, which has culminated in the establishment of universities in India. It is generally believed that they sprang into life like Minerva, ready formed and without incubation, from the brain of Jove, as no connective narrative of so much of Indian education as relates to the highest order of collegiate instruction has ever been published in England that I am aware of.

As I was in executive charge of the education of the most important and advanced province of India (Lower Bengal) for nearly thirteen years — 1841-1854 — during which period the greatest advance was made on the subject; and, as the details of public instruction, so far as the institutions connected with the State are concerned, were then probably better known to me than to any man now alive, I consider the matter of sufficient public and historical interest to be placed on record in a connected form, accessible to all at home. It would not, I think, be right for me to attempt to conceal that my chief motive is purely personal, as well as in justice to the pioneers of a truly great work, to some of whom full justice has never been done, in all th has heretofore been published on t subject.

I shall endeavour to trace the steps whic after forty years of patient and laborious exe tion, were at length crowned with success 1854. My knowledge of them was gain chiefly in my public capacity, and in o province, and to them I shall restrict m review. It must not be supposed, howev that I am unacquainted with the work private individuals and of the missiona bodies in the same direction during tho eventful years, or that I undervalue them. was on terms of intimacy with many of t most eminent members of the latter, frequent visited the institutions under their charge, well as discussed with them so much of t question as related to secular education; a I entertain the greatest admiration, reverenc and affection both for them and their wor Chief among these was my near neighbour the native town, Dr. Duff, than whom a mo noble-minded, gifted, devoted, and successf labourer in missionary work has nev existed. He believed in education as t chief and most effective instrument for th propagation of the Gospel, and to it accor ingly his pure and spotless life, his marvellou energy, his wonderful influence over the mind of the young, his fearless courage, and h profound knowledge of the work in which h was engaged, were devoted with an ardou that never flagged from first to last. I accom panied him for a great part of his way, recruit his broken health, in one of his visits Europe, and spent the greater part of the tim we were on board together, in constant con verse on subjects in which we had a mutu interest. My reverence and affection we intensified by what I witnessed of his undyin faith and singular simplicity of life; and nev did I utter with more heartfelt sincerity, " *si sic omnia*," than when I parted from him o that occasion.

The order in which I shall consider as brief as I can the stages of progress, with du regard to the necessity of producing authenti proofs of the accuracy of my narrative, will b strictly chronological, from the real origi of the movement in 1816, to the great Educa tional Dispatch of 1854, its culmination. Th steps, then, were—

1. The establishment of the Hindu Colleg of Calcutta, in 1816.

2. Lord Macaulay's minute, and the officia adoption of the English language as the basi

public instruction, by Lord William entinck, in 1835.

3. The establishment in the same year of the edical College of Calcutta.

4. Lord Hardinge's educational resolution October 10th, 1844.

5. The elaboration and submission to the ling authorities in India and in England of the heme of an University in Calcutta, which known as the scheme of the Council of ducation, and of which I claim the paternity, ithout in any way questioning the propriety the above appellation.

6. The remodelling of the Mahommedan and indu Colleges of Calcutta, and the creation the Presidency College of Bengal, after long nd careful consideration, in 1853.

7. The great Educational Dispatch of 1854, ne last, and not the first link in the chain.

I.—The Hindu College of Calcutta.

In Appendix No. VI. to No. XIV. of the Selections from the Records of the Government of Bengal," is contained a brief history f the Hindu College, compiled by myself from ne unpublished records of that institution.

From this it appears that on the 1st of May, 316, a meeting of European and native entlemen was held, to establish an institution r giving a liberal eduction to the children of espectable members of the Hindu community. he proposal received the unanimous approval all the natives present, including the most minent Pundits, who sanctioned it with their xpress support and recommendation. A large um of money was subscribed, the institution eceived the name of the Hindu College of alcutta, the members of the Supreme Government became its patrons, and a very strong ixed committee of Europeans and Indians as appointed, to give effect to the resolutions f that and of a subsequent meeting, held to omplete the design. The Chief Justice of engal was the first president, and the Chief udge of the Appellate Court the first vice-resident of the institution.

The primary object of the Hindu College as declared to be "the tuition of the sons of espectable Hindus in the English and Indian nguages, and in the literature and science of urope."

A native committee was appointed to direct nd control the college, which was carried on ith varying success and ultimate failure, ntil, to prevent its collapse and extinction, it as compelled to appeal to the Government or aid and recognition, and was brought under the general control of the educational authorities, the rights of the original subscribers being carefully safe-guarded. This was the real commencement of education on a sound basis, and in the English language, for in the Oriental department was taught only Bengali, the vernacular language of the province; Sanscrit, the classical language of the Hindus, being taught in special colleges in Calcutta and Benares.

It is not necessary to follow further the fortunes of this institution, which, chiefly under European guidance, became in the course of time the first Anglo-Vernacular College in the Province, until, from circumstances to be narrated hereafter, its special character was changed it was opened to all classes and creeds, and, under the name of the Presidency College of Bengal, became a teaching college, organised as an University, and in effective operation in 1853, before the great dispatch of 1854, authorising the establishment of Universities in India, was even written.

II.—Lord Macaulay's Minute.

The next stage of the movement was probably of even greater importance, when the controversy of the contending Orientalists and Anglicists terminated in the official recognition and permanent adoption of English as the basis of instruction in all the higher branches of collegiate education, and in the secondary zillah schools, established at the head-quarters of each district of Lower Bengal.

It is needless to reproduce the elegant and forcible terms in which Lord Macaulay characterised the beauty and majesty of the English language; the vast scope and richness of its literature, and the universality of its application to all the purposes of art, science, social life, and government. They are contained in his life by his nephew, which is universally known. Due provision was made for the cultivation of the classical languages of the East, in the existing Sanscrit and Mahommedan colleges.

Bishop Thirlwall, in an admirable discourse delivered at University College in London, also advocated the study of English in a manner which shows, if further proof were necessary, how wise was the advocacy of Macaulay and the action of Lord William Bentinck in the matter, half a century since. They are worth reproducing, because a very eminent man, who has recently been lost to his country, appeared to think that the study of English in

India had been productive of grave and unexpected results, which might become a source of public danger.

"English," the Bishop said, "deserves the best cultivation we can bestow upon it, not only on account of its historical importance, but likewise of its intrinsic worth. We have no need to wince at the sneers which Alfieri, when indignant at the comparative neglect of his own sweet Italian, throws out at those languages which gain currency at the point of the bayonet, and are propagated by the movements of fleets and armies! The diffusion of our language has followed in the train of that series of pacific triumphs which has carried civilisation to the furthest corners of the globe."

He also adduces in support of his views the testimony of one who stands the highest in this department of knowledge—the prince of German philologists—Jacob Grimm, who says of the English language, "that it has the fullest right to be considered as a universal or world language—that it is evidently destined by Providence to prevail over the remotest quarters of the world, as widely as the English nation itself." "And," he adds, "that for copiousness, for sense or logic, I may call it *vernuft;* and for conciseness of expression, there is no living language (not even his own) which can be justly placed by its side."

III.—The Medical College of Calcutta, March 1st, 1835.

Immediately following the introduction of English was what has been rightly regarded as the crowning act of Lord William Bentinck's administration, the creation of the Medical College of Calcutta, to supersede the medicine of the Greeks, Arabs, and Hindus, and overcome one of the most deep-seated of the prejudices of the latter. "Contact with a dead body," says one of the best historians of the period, "had for twenty centuries been considered a moral pollution by the Hindus," in consequence of which, "sage men of long experience predicted the failure of the experiment," as native prejudices were deemed to be invincible. It is now, and has for some years, been one of the first schools of anatomy in the world, and too much honour can never be paid to the memory of the first Hindu of high caste who broke this spell of ages, Pundit Madu Sudan Gupta, an old and valued friend of mine.

When the administrative and executive charge of this important institution was placed in my hands in 1841, it had been doing its appointed work with care, caution, and success but, as my predecessor in this office, Mr. Dav Hare, whose name is venerated in Calcutt had not, from his previous life and trainin any experience of the real nature of the duti required in that position, it fell to my lot organise and place it on the footing efficiency which it has never ceased to retai Rules and regulations were then framed for a departments of the college; the course study in every branch of a complete medic education was carefully fixed by the professo and teachers of each. Special attention wa paid to the dissecting department; the ho pital attached to the college was fully utilise for the treatment of the sick, and for clinic and pathological instruction; an obstetri ward was added; and quarters were built f the students of the native military clas and afterwards for a more advanced cla of pupils from Ceylon and the North-We Provinces, as well as for the apothecary' department of the European army. Th resident students soon numbered nearly 20 All creeds and castes dwelt together i harmony, and gave me comparatively littl trouble in the maintenance of discipline, whic was one of my multifarious duties.

The college was the first of its class i British India, and formed the model on whic others were afterwards instituted at Bombay Madras, Agra, and Lahore.

As soon as it was brought into thoroug working order, its lectures were acknowledge by the Royal College of Surgeons and othe examining bodies in England, and those of its Indian students who have visited Europe since, in order to obtain degrees and diplomas, have acquitted themselves well, and competed successfully for honours and rewards with their European contemporaries.

A more complete medical faculty was never added to any university than that of the medical college to the Calcutta University, when it was sanctioned in 1854.

Among its professors were some of the most eminent members of the medical service in India. Anatomy was represented by Messrs. Webb, Walker, Pearson, and R. O'Shaughnessy; botany by Wallich, Falconer, Griffith, and Thomson; surgery by R. O'Shaughnessy, Fayrer, and others of equal eminence; medicine by Jackson and the two Goodeves; chemistry by Sir Wm. O'Shaughnessy, who introduced telegraphy into India; and others who then, as now, were all eminent men. In this college native competed on equal terms

ith European students for honours, and the ›rmer were most frequently the victors.

When I took Sir Charles Napier, the re- ›owned warrior, over the college, and explained › him the manner in which all caste and ›cial prejudices were quietly, firmly, and ıccessfully overcome, he declared that if the :my in India had been ruled with equal ›mmon-sense, its discipline and fighting ›wer would have been greatly increased.

V.—Lord Hardinge's Resolution of October 10, 1844.

In the parting address of the Chairman of ıe Court of Directors to Lord Hardinge, on is leaving England to assume the reins of ıe Government of India, occurred the follow- ıg passage relating to education in that ›untry:—

"It has long been the desire of the Court (of irectors) to encourage education among the people India, with a view of cultivating and enlarging eir minds, of raising them in their own and in our timation, and of qualifying them for the more sponsible offices under our Government. It is, ›wever, necessary, with reference to the subject of lucation, to exercise great prudence and caution, in der to avoid ever the appearance of interference ith their religious feelings and prejudices, and to aintain on such points the strictest neutrality."

There is no indication here of the inertness · indifference of the official conscience at ›me, and there was equally little proof of its ›istence abroad. Lord Hardinge landed in alcutta on the 23rd of July, 1844, and on the ›th of the succeeding October appeared his ımous resolution, giving effect to the instruc- on he had received in public at one of those ıaint old ceremonials which have since dis- ppeared into history.

The resolution was actually drafted by the ›te Sir Cecil Beadon, one of the most trusted › Lord Hardinge's counsellors. It was re- ›ived by the educated natives of Calcutta ith immense enthusiasm. A meeting was ›ld in December, and attended by 500 native entlemen, who framed an address on the ıbject, which was presented to the Governor- eneral. In his reply, that eminent and ex- ›llent ruler informed the deputation "that he dvocated education as mutually beneficial to ıe governor and the governed; that he felt ıe advantages to Government of the minds of atives of superior intelligence and integrity;" ut added that "he encouraged learning on the ır higher principle that it increased the happiness and prosperity of society;" and he concluded by stating emphatically:—"Rely upon it, gentlemen, you cannot perform a more patriotic service to your countrymen than by encouraging and promoting education among the native population."

These sentiments he repeated at greater length when addressing the Hindu and Mahommedan students on presiding over the distribution of prizes to their respective colleges in 1845.

The failure of the Hindu College, from its exclusive character, to accomplish fully the purpose for which it was created, had struck others as well as Sir Cecil Beadon.

Subjoined is the resolution referred to, *in extenso*, which it merits from its intrinsic value, because it is a permanent landmark, and because it is scarcely known at all in England, and is now nearly forgotten even in India, so fleeting is the public memory in that country, and so little attention is paid amongst us to such matters.

When I was at home on furlough in 1854, I met at Baron Liebig's, in Munich, the members of a congress of educationists from all parts of Europe, who were engaged in considering some of the questions still unsettled in England on primary and secondary education. I was introduced to them by the Baron as one recently returned from India, and connected officially with public instruction in that country. I was received with great courtesy and consideration, and put through a severe examination as to what was being done in Calcutta and elsewhere in that important direction. They exhibited a far more accurate and extended knowledge of our proceedings than I found to exist anywhere in England—a matter, I submit, of little credit to us.

The main intention of the resolution was to give the preference, in selection for public employment, to all candidates who had studied in public or private schools, and produced evidence of proficiency and merit in those studies. It was believed that it would in this way act directly in improving education generally, from the universal desire of seeking public employment.

The text of the resolution is as follows:—

"The Governor-General having taken into his consideration the existing state of education in Bengal, and being of opinion that it is highly desirable to afford it every reasonable encouragement, by holding out to those who have taken advantage of the opportunity of instruction afforded to them, a fair prospect of employment in the public service

and thereby not only to reward individual merit, but to enable the State to profit as largely and as early as possible by the result of the measures adopted of late years for the instruction of the people, as well by the Government as by private individuals and societies,—has resolved that in every possible case a preference shall be given in the selection of candidates for public employment, to those who have been educated in the institutions there established, and especially to those who have distinguished themselves therein by a more than ordinary degree of merit and attainment.

"The Governor-General is accordingly pleased to direct that it be an instruction to the Council of Education, and to the several local committees and authorities charged with the duty of superintending public instruction throughout the provinces subject to the Government of Bengal, to submit to that Government, at an early date, and subsequently on the 1st January in each year, returns (prepared according to the form appended to this resolution) of students who may be fitted, according to their several degrees of merit and capacity, for such of the various public offices as, with reference to their age, abilities, and other circumstances, they may be deemed qualified to fill.

"The Governor-General is further pleased to direct that the Council of Education be requested to receive from the governors or managers of all scholastic establishments, other than those supported out of the public funds, similar returns of meritorious students, and to incorporate them, after due and sufficient inquiry, with those of Government institution; and also that the managers of such establishments be publicly invited to furnish returns of that description periodically, to the Council of Education.

"The returns, when received, will be printed and circulated to the heads of all Government offices both in and out of Calcutta, with instructions to omit no opportunity of providing for advancing the candidates thus presented to their notice, and in filling up every situation of whatever grade in their gift, to show them an invariable preference over others not possessed of superior qualifications. The appointment of all such candidates to situations under the Government will be immediately communicated by the appointing officer to the Council of Education, and will by them be brought to the notice of the Government and the public in their annual reports. It will be the duty of the controlling officers, with whom rests the confirmation of appointments made by their subordinates, to see that a sufficient explanation is afforded in every case in which the selection may not have fallen upon an educated candidate whose name is found on the printed returns.

"With a view still further to promote and encourage the diffusion of knowledge among the humbler classes of the people, the Governor-General is also pleased to direct that, even in the selection of persons to fill the lowest offices under Government, respect be had to the relative acquirements of the candidates, and that in every case a man who c read and write be preferred to one who cannot."

For the highest standard the Council Education selected their own senior schola ship course. This proceeding gave rise to considerable and warm controversy at th time, as it was contended that it was impo sible of attainment by any of the advance students of private institutions, for variou reasons, and virtually gave a monopoly of th higher appointments to the State college This acknowledged discontent at lengt reached the Government, and in 1847, di patches from the Court of Directors were com municated to the Council of Education, int mating their belief that the objections to th action of the Council were well grounded, an directing a re-consideration of the matter.

The Deputy-Governor of Bengal, Sir Herbe Maddock, also noticed it in his speech at th distribution of prizes in the town-hall, in 1847 and recommended the Council to place them selves in communication with the authorities c private institutions, with a view to ascertai their opinions on the subject, so as to sugges such modifications of the standard as migh appear expedient and necessary.

This was done, and a public meeting wa held, at which the objections were clearly an forcibly stated, and forwarded to me for sub mission to the Council, with an able an earnest exposition of their meaning, by Dr Duff, who presided at the meeting. His view were stated to embody only his persona opinions. By the Council they were carefull considered, and their procedure in the mai was justified and adhered to, their conclusio being that:—

"The Council beg leave to observe that no objection is taken to the extent of the standard, which the Council concur with Sir Herbert Maddock in deeming it undesirable to lower. At the same time the Council allow that the nature of the standards admits of alterations, but they are not now prepared to enter on the consideration of that question. The present standard has been and can be readily attained by the pupils of any efficient and well-organised public or private school. To reduce it would tend to encourage pupils to become contented with a superficial amount of knowledge, and to enter upon the active duties of life before the maturity of their reasoning faculties, the formation of their character, and the principles implanted by a more extended course of study had time to produce their full effects."

This well-intentioned effort of the Government to acknowledge officially, and encourage,

or the first time, the education given in private nd missionary institutions, and to associate ll in the bestowal of the minor administrative ffices of the State, was doomed to inevitable ailure from the very beginning, without any eference whatever to the battle of the stand- rds. The country was not ready for such a neasure; the agency provided to deal with t was altogether insufficient for the purpose; nd the attempt to transfer the patronage of ll local and departmental offices to an irres- onsible central office, which was already vertasked, was passively, and successfully esisted at once. I was at first overwhelmed vith correspondence on the subject, which I vas quite unable to deal effectively with. Very ew candidates ever presented themselves or vere included in the Council's lists, and few f those who were successful succeeded in aining the appointments they coveted. Things continued to run in their accustomed hannels, and the resolution died from nanition, without a struggle—passing into blivion, unobserved, and unrecorded. I do not leem it necessary, therefore, to refer farther o it. Yet, notwithstanding its failure, it was remarkable step in advance, which has ince been followed at home, and it would ot have been right to omit all mention of it.

V.—The University Scheme of 1845.

I now come, in strict chronological order, to he university scheme of 1845. Regarding it must speak much of myself, which I greatly egret, both because egotism is in every case listasteful, and to no one is it more so than to nyself, and because it is unusual for a member nd executive officer of a public body to sepa- ate himself, even partially, from that body, nd to claim any portion of its public work as lue to his initiative and to be in reality his wn work. However much it may be opposed o custom, I could, if necessary, adduce xamples in which it has been claimed and llowed in legislative and scientific matters. Even were it not so, it seems to me to be per- ectly legitimate to create a precedent when ufficient grounds can be shown to justify it, nd this I shall now endeavour to do.

When I joined the Council of Education as s a member and secretary of that body, I eally occupied the position, in practice, of a lirector of public instruction, with a superior onsultative council, to whom I was to refer mmediately all questions of principle not ncluded in the ordinary routine duties of the office. The instructions of the council I was bound to obey, and carry into effect at once. The ordinary routine duties were nominally entrusted to the president and secretary, but by the former invariably, during my incum- bency, confided to the latter. An abstract report of all work accomplished in this manner in the intervals of their meetings was laid upon the table of the council at each of their meetings, and all references involving ques- tions of principles or practice for which there were no precedents, and which needed discus- sion and special orders, were placed on an agenda-list, and, after consideration, were embodied in resolutions, circulated for the information of the Council, and acted upon as soon as they had been approved. Even of these, the Council in the circulation of the papers, usually noted that which they did not consider it necessary to discuss, and left it to the decision of the president, and marked only such as they desired themselves to consider. In this manner much of the time of the Council was saved. Numerous references to the Government were rendered unnecessary, which an independent director would have to submit, and in the whole of the many years during which I was the executive officer of the Council, I have much pride and pleasure in recording that, in the multitudinous actions embraced in that lengthened period, there was not a single personal difference between my- self and my colleagues and superiors.

When I joined, therefore, and had person- ally visited all the colleges and schools under the charge of the Council, and had become acquainted with the standards in use, I was at once struck with the absence of any definite aim and object in the system of education adopted in all but the Medical College, in which I played the part of a teacher, as well as controller. It appeared to me that a great scheme of public instruction, worked by an able staff, and turning out annually numerous scholars of considerable merit and attainments, needed some means of acknow- ledgment of the position they ought to occupy, as men of culture and education. I rapidly arrived at the conclusion that nothing short of a university, having the power to grant degrees, would accomplish this purpose. And above and beyond this, from the indications of eagerness to acquire knowledge which I witnessed in every direc- tion, I felt that no surer means to foster and encourage education generally could be devised.

I accordingly placed myself at once in com-

munication with my friend Professor Malden, of University College in London, wherein I had been a student in the faculties of arts and medicine, but in which I took no degree, as none were then or afterwards granted.

From the information which I placed before him, Professor Malden considered Bengal to be perfectly ready for the establishment of universities, and sent me a copy of the history of those institutions in Europe, written by himself.

I then conferred with the president, Mr. Charles Hay Cameron, on the subject, told him what I had done, and found him, not only satisfied with the correctness of my views, but quite prepared to have them brought to the notice of the Council, as he had himself arrived at the same conclusion previously.

It was accordingly determined to put forth a brief notice on the subject in the report of 1844-45 as a feeler, and to prepare a detailed scheme as soon as possible afterwards for consideration by the Council, and for submission to the Government should it be approved after discussion. I was directed to prepare the scheme, which I did accordingly, and, during its preparation, I conferred with every person in Calcutta, both in and out of the service, whom I believed to possess any knowledge of the subject, and any interest in it. Not one of those consulted, however, added a single word to the scheme as drafted by me, which, with the explanatory statement appended to it, was absolutely my own work. It was adopted as it stands by the Council of Education, and was published in the Council's report in 1845-46, at pages 11-14. My original MS. was still in the records of the Department when I left India in 1870. With this preamble, I now produce it *in extenso*, as it is not generally accessible in England, and I shall have to refer to it again when I come to the final link in the chain in 1854.

It will be seen that this scheme embraced in its scope and included all educational institutions, whether connected or unconnected with the Government, and imparted to it the catholicity upon which so much stress was rightly laid upon the promulgation of the Educational Dispatch of July 19, 1854. Indeed, that dispatch borrowed it directly from the Council's scheme, which is accepted in its integrity, with such additions only as no authority in India had the power to make.

"Among the most important events of the past year (1845-46) was a proposal which we submitted for establishing a central University in Calcutta, of which the following outline was forwarded for the information and orders of the Government:—

PROPOSED PLAN OF THE UNIVERSITY OF CALCUTTA.

"The present advanced state of education in the Bengal Presidency, with the large and annually increasing number of highly-educated pupils, both in public and in private institutions, renders it not only expedient and advisable, but a matter of strict justice and necessity, to confer upon them some mark of distinction, by which they may be recognised as persons of liberal education and enlightened minds capable, from the literary and scientific training they have undergone, of entering at once upon the active duties of life; of commencing the practical pursuit of the learned professions, including in this description the business of instructing the rising generation; of holding the higher offices under Government open to natives, after due official qualifications; or of taking the rank in Society accorded in Europe to all members and graduates of the Universities.

"The only means of accomplishing this great object is by the establishment of a central University, armed with the power of granting degrees in Arts, Science, Medicine, Law, and Civil Engineering incorporated by a special Act of the Legislative Council of India, and endowed with the privileges enjoyed by all chartered universities in Great Britain and Ireland.

"After carefully studying the laws and constitutions of the Universities of Oxford and Cambridge, with those of the recently-established University of London, the latter alone appears adapted to the wants of the native community.

"This University was incorporated by Royal Charter, dated the 5th December, in the first year of the reign of Queen Victoria, under writ of Privy Seal, constituting the persons named a Chancellor, Vice-Chancellor, and Fellows, one body politic and corporate, by the name of the 'University of London.' In this charter are defined the mode of appointing and electing the officers above-mentioned, their constituting the Senate of the University, with the power of granting degrees in Arts, Science, Medicine, &c.

"Upon a similar plan, and for the same objects, it is proposed that the University of Calcutta shall consist of a Chancellor, Vice - Chancellor, and Fellows, as follows: — *Chancellor and Visitor.** — The Governor - General of India. *Vice - Chancellor.* — The President of the Council of Education. *Fellows—Law Faculty.*—The Judges of the Supreme Court, the Judges of the Sudder Dewanny Adawlut, the Advocate - General, the Registrar of the Sudder Dewanny Adawlut, and the Remembrancer of Legal Affairs. *Faculty of Science and Civil Engineering.*—The Chief Engineer,

* During the absence of the Governor - General, the functions of Chancellor and Visitor to devolve on the Deputy-Governor of Bengal.

he Superintendent of Government Machinery, the Secretary to the Military Board, and the Civil Architect. *Faculty of Medicine and Surgery.*—The Physician-General, the Inspector-General of her Majesty's Hospitals, the Surgeon to the General Hospital, the Secretary to the Medical Board, and he Apothecary-General. *Faculty of Arts, and for general control and superintendence.*—The Secretary o the Government of India, Home Department, the Secretary to the Government of Bengal, the Council of Education, and the Secretary to the College of Fort William.

"The above to form the body politic and corporate o be styled the 'University of Calcutta,' to constitute the Senate for its government, to be armed with the legal powers, accorded to all such bodies, by Royal Charter in Great Britain, and to frame bye-laws and regulations for the granting of degrees* and diplomas.

"The powers and authority of the Chancellor and Visitor to be such as pertain to those officers in Europe.

"The Vice-Chancellor and Fellows to have the entire management of, and superintendence over the affairs, concerns, and property of the University, for framing bye-laws and regulations for degrees, granting the same, convening meetings, 'and, in general, touching all other matters whatsoever regarding he said University.'

"Six members to form a meeting for the decision of all questions relating to the University, and all such questions to be decided by the majority of members present, the Chairman having a vote, and, in case of an equality, a second or casting vote. In he absence of the Vice-Chancellor, a chairman to be chosen by the members present.

"An examination of candidates for degrees in all departments to be held at least once a year, and conducted either by examiners appointed from among he Senate, or by any others specially nominated by hat body.

"The benefits of these examinations to be extended o all institutions, whether Government or private, approved by the Senate, provided the candidates from such institutions conform to such regulations as may be enacted respecting the course, extent, and duration of study, and produce the certificates that will be required, authority being granted for the issue of the same.

"A regulated scale of fees to be determined hereafter, for degrees and diplomas, to form a fee fund for the payment of the expenses of the University, of which an account is to be furnished annually to the Financial Department of the Government of India.

"The names of all candidates receiving degrees and diplomas to be published annually in the Government *Gazette*, as well as in the reports of the Education Department.

* As degrees are unknown here, it will be expedient to describe them in the Act, together with the privileges attached o them.

"*Outline of Proposed Regulation.—Matriculation Examination.*—All pupils intending to be candidates for degrees or diplomas in arts and science, civil engineering, or medicine, or surgery, shall pass a matriculation examination, of which the standard shall be the present junior scholarship standard of the Council of Education; except in the case of pupils from the Martiniere, Parental Academy, and similiar institutions, for whom translations from and into Latin and Greek, if the candidates prefer them, shall be substituted for vernacular translations.

"No candidate shall be allowed to matriculate until he has completed his fifteenth year.

"Every candidate shall pay a matriculation fee of five rupees prior to the examination, which shall be returned to him if he should be rejected.

"*Arts and Science* shall consist of a Bachelor's and Master's degree, with a special examination for honours of those who may have passed.

"Course of study, subjects of examination, fees, and other details to be arranged hereafter by the Senate, should the University be established and incorporated.

"*Law*, likewise, to consist of two grades, with an examination for honours; and graduates to be legally entitled to practise at the Bar of the Supreme or Sudder Courts, to act as attorneys and vakeels, to be considered qualified for the appointment of moonsiff, sudder ameen, &c., and to form a distinct legal profession for the Indian Empire.

"Detailed regulations to be determined by the Judges and other legal members of the Senate.

"*Civil Engineering.—One Examination and Degree.*—The course of study, qualifications, nature and extent of examination, &c., to be decided by the engineer members of the Senate, so as to raise up ultimately an indigenous class of engineers in the Government service, as well as native architects, builders, surveyors, &c.

"*Medicine and Surgery.*—Two examinations, one for the degree of graduate in medicine, and the other for a diploma in surgery, together with a special examination for honours. Details to be arranged by the medical members of the Senate, in communication with the Council of the Medical College.

"The above is a rough outline of a plan, the carrying out of which would form one of the most important epochs in the history of education in India. It would open the paths of honour and distinction alike to every class and institution, and would encourage a high standard of qualification throughout the Presidency, by bestowing justly earned rewards upon those who had spent years in the acquisition of knowledge, and by rendering their literary honours a source of emolument, as well as a social distinction. It would remove most of the objections urged against the existing system of examination of candidates for public employment, without lowering the standard of information required, and would, in a very few years, produce a body of native public servants superior in character, attainments, and efficiency to any of their predecessors.

"It would encourage the cultivation of the arts and sciences, and call into existence a class of native architects, engineers, surveyors, and educated landholders, whose influence would rapidly and certainly diffuse a taste for the more refined and intellectual pleasures and pursuits of the West, to the gradual extinction of the enervating and degrading superstitions of the East. Increased facilities of intercourse, by means of railroads, with the interior of the country, the North-West Provinces, and with Europe, would cause these influences to radiate from the centre of civilisation, with a velocity and effect heretofore unknown in India, and, in fact, would be attended with all the advantages that have been recorded in history, to have followed a judicious, enlightened, extended, and sound system of education, encouraged by suitable rewards and distinctions.

"The adoption of the plan would only be attended with a very trifling outlay to Government in the commencement, for, in the course of a few years, the proceeds of the fee fund will be more than sufficient to defray every expense attendant upon the University.

"It would raise the character and importance of the whole Education Department in public estimation, and ultimately place the educated natives of this great Empire upon a level with those of the Western World.

"That the time for such a measure has arrived is fully proved, by the standard of excellence attained in the senior scholarship examinations of the Council of Education,* and the creditable skill and proficiency exhibited by the graduates of the Medical College, whose examinations, in extent and difficulty, are much greater than those of any of the Colleges of Surgeons in Great Britain, and, in a purely professional point of view, nearly on a par with those required from the medical graduates of most British Universities.

"We considered that it would be premature to organise the different departments in detail, until the general plan had been approved of, which approval we were anxious to obtain, with a view to procure at once, through the proper channel, the sanction of the Crown to a measure in which the royal prerogative is concerned. On this account, the Honourable the Chief Justice of the Supreme Court and Sir Henry Seton expressed their inability to join the institution, as some of the proposals contained in its plan were immediately connected with their official position, and required the sanction of the authority under which they act before they could themselves express any opinion to its merits, or take any active share in its proceedings.

"The Council also did not deem it necessary to enter into any detailed explanation of the motives which led to the present proposal, as the published records of the Department amply prove the high standard of acquirement which has been attained and the history of the progress of letters in Europe demonstrates the great and powerful stimulus to advancement afforded by the grant of scholastic honours and rewards, ever since the revival of learning in the middle ages.

* Fully equal in extent to the Bachelor's examination of Oxford, Cambridge, and Dublin, and much more so than that of the Bachelier-es-Lettres of the Sorbonne in Paris.

"With reference to the details referred to, we are in communication with most of the eminent members of our community who are likely by their knowledge, position, and practical acquaintance with the subject of education, as well as the peculiar wants of the Indian public, to assist us in maturing and perfecting such a scheme as will be worthy of the high end proposed, and tend to the moral and intellectual advancement of the magnificent Eastern Empire entrusted to the British Nation.

"It would be easy to dwell at great length upon this topic, and prove to a demonstration the accuracy of the views embodied in our plan, were it not considered a work of supererogation to elaborate that which is self-evident, and has received the confirmation of historical record in all countries, and among all nations possessing universities, and exhibiting the striking effect produced by their establishment, in advancing the moral, social, and intellectual condition of the people.

"We were gratified by your informing us, on a recent public occasion, that our views were coincided in by the highest authorities in this country, and that our plans had been recommended for adoption to those in Europe who possess the power of directing them to be carried into effect.*

This leads me to the fifth stage of progress, one of the most important of all, as it proves the continuous action of the Council of Education in the direction of the establishment of universities in India, which had never been lost sight of since the rejection of the scheme above referred to. It contains a proposal to provide a teaching university, which would, I am of opinion, have been far more useful to Bengal than the form actually adopted. The general and practical direction of public instruction in the whole of the interval had been in my hands, and I claim, therefore, to speak with authority on the subject.

VI.—The Presidency College of Bengal.

Shortly before the death of Mr. Bethune, then President of the Council of Education, two events occurred, one in the Hindu College School, and the other in the College itself. The first was the accidental admission to the school of a low caste boy, which was in contravention of the guaranteed condition that the sons of none but respectable Hindus should

* General Report on Public Instruction in the Lower Provinces of the Bengal Presidency for 1845-46.

e admitted, the test of respectability being hiefly that of caste. The Hindu managers esented this, and after an inquiry, conducted, f I remember rightly, by myself, it was established that the boy had found admission by raud and falsehood, and he was at once dismissed.

The next incident was that of the conversion o Christianity of a native teacher in the ollege, whose dismissal was insisted on by he native managers, although a most careful nquiry proved that he had never abused his osition as an instructor to influence any of he students, either directly or indirectly, to ollow in his footsteps. The college was nder the general control of the Council of ducation, whose authority and sanction were ecessary to give effect to the desire of the Hindu managers. That sanction was courteously and firmly withheld.

Among the managers referred to were some ative gentlemen of position and authority, ho were deservedly held in high esteem by heir co-religionists. The important question nvolved was, therefore, discussed and considered in an amicable spirit by private and ersonal negociations, to which publicity was ot given, for obvious reasons. Both parties ere unwilling to injure the cause of education generally by a violent disruption, or to isturb unnecessarily the perfect harmony hich had existed ever since the institution ad been placed under the control of the ducational authorities. A small committee as therefore appointed to go into the matter horoughly, and to discover, if possible, a *nodus vivendi*, without the sacrifice of the reat principle underlying it, of the perfect eutrality of the State in questions of religion.

This committee consisted of Mr. Bethune, he President of the Council, the late Sir Cecil Beadon, and myself, and we conferred accordingly at the college with the ative managers. These gentlemen adhered irmly to their contention, and the advoates of Christianity as resolutely declined o abandon the position that a teacher who ad embraced that faith had committed no isciplinary or other offence which would ustify his removal. A teacher so situated had ot diminished his value and efficiency as an nstructor, or in any way invalidated the conditions of his service, even in an institution confessedly established for the education of Hindus exclusively. The most able member f the native management, a gentleman of dvanced sentiments, intimated that all religions were matters of perfect indifference to him, and that he regarded the question as purely one of a grave breach of contract with the founders of the college, of whom he was one. Assuming that this line of argument would be adopted, the conditions connected with that foundation had been carefully studied prior to the meeting, and no condition sanctioning that view was found or existed. One of the most eloquent and earnest defences of Christianity in its influence on conduct and character that I have ever heard, was made by Mr. Bethune, who intimated that the Christian religion could never be a matter of indifference to any person sincerely professing it.

The result of a very protracted discussion was that no compromise was possible. The Hindu gentlemen therefore intimated their intention to establish another institution of their own on the same principles, and to withdraw altogether from the Hindu college.

As much of the story as could then be told is contained in No. XIV. of "Selections from the Records of the Bengal Government." The way was thus unexpectedly cleared, the Hindu College was made over to the Council of Education, all legal rights were safeguarded, and funds belonging to them were made over to the Hindu managers for transfer to their new institution. In the manner in which the solution was affected, those gentlemen behaved with great courtesy and consideration, which received the acknowledgments of the Indian Government and the Home authorities.

The Council set to work at once to convert the exclusive into a general institution of the highest order, for the education of all suitable persons, irrespective of their religion or faith, and submitted to the Government the draft of a scheme, reporting all they had done, and the measures they deemed it desirable to carry into effect, a design intended to place the education of the capital of the country upon a basis suited to its importance, and worthy of the dignity of the Government.

The Government, in reply, dated October 21, 1853, adopted the proposals of the Council in principle, and in most of the details; enlarged the scope of their intentions, suggested certain changes of detail, and concluded their answer in the following memorable words:—

"Having thus drawn the outlines of the educational scheme which appears necessary for meeting existing defects, and to be best adapted to the ends in view, his Lordship will leave it to the Council of

Education, if they should see fit to adopt the extended plan, to work out its details, and submit it in a complete form for final sanction. His Lordship hopes that this may not occupy much time, and that before he resigns the active administration of the government of Bengal he may have the satisfaction of seeing the educational institutions of the capital placed upon a footing adequate to the wants of the community, and worthy of the government of the East India Company."

The Council replied (March 10, 1854) that, "being fully convinced that the design whereof the outlines had been drawn by his Lordship, if maturely worked out in its details, and intelligently and liberally superintended in its operations, will place the educational institutions of the capital," upon the footing laid down by his Lordship, "and, believing that nothing short of that design will accomplish this end, have proceeded joyfully in their present task."

When this was written, the arrangements for the transfer of the Hindu College had been completed satisfactorily, and it had been made over to the Council formally on the 11th of January, 1854. I had been directed by the Council to collect all the information necessary to convert the college into the nucleus of a teaching university, and to work it into a complete scheme embodying the organisation, professorial staff, course of instruction, examinations, rewards, financial and other collateral and subsidiary details necessary to give effect to that direction. This proved to be a task of considerable labour and difficulty, which occupied me the whole of the two months prior to the submission of the scheme to the Government. When I had completed it, and reported its completion and submitted it to the Council, by whom it was gone through carefully, it was referred specially to Sir J. P. Grant and myself to determine finally the exact form it should take. To that ripe scholar and exceptionally able administrator it owes the terms of eulogy and high approval with which it was received by the Marquis of Dalhousie, as Governor of Bengal.

I can only give in this place a very general and brief outline of the scheme. The college was divided into four branches or faculties, for each of which a distinct course of education, qualifying for a diploma, was laid down. The four branches were to consist of a general, medical, legal, and civil engineering departments, of which the conditions of study, &c., were defined.

The colleges and schools throughout th[e] provinces were to be associated in this schem[e] by means of bursaries, and any stranger wa[s] to be allowed, by the payment of a moderat[e] fee, to attend any particular course of lecture[s] but no examination was to be made of suc[h] stranger.

The intention of this was to throw open th[e] advantages of this university training to th[e] pupils of all private and missionary institution[s] at the Presidency which did not possess th[e] staff and means of instruction in them, suc[h] as political economy, chemistry, botany, natural history, law, and civil engineering.

The proposed subjects of study were:—

General Branch.

Languages and Literature—English, Latin Vernacular.

History—English, Indian.

Philosophy—Mental, Moral.

Logic.

Political Economy.

Mathematics—Geometry, Algebra, Highe[r] Analysis.

Chemistry, including Light, Heat, and Electricity.

Physics — Natural Philosophy, including Astronomy; Natural History, including Vegetable and Animal Physiology and Geology.

Legal Branch.

General jurisprudence, elements of civil law, elements of international law, English law so far as applicable to India, Hindoo law, Mahommedan law, mercantile law, the municipal laws of Bengal (civil and social), procedure of Courts, tenure of land.

Civil Engineering Branch.

Drawing, the use of instruments, surveying, machinery, materials, architecture, mining and economic geology, roads, bridges, railways, canals, and embankments.

Medical Branch.

A continuance of the complete courses of medical education then and for years in operation at the Medical College.

The course of study in each of the three branches was explained in some detail, and changes of system in some of the branches then taught in the college, were recommended. A college staff, on a strictly economical principle, dictated by financial considerations, was suggested. The staff was to be charged to deal

with all branches, and additional professors for the new branches were to be entertained.

The cost of this staff was thus estimated at about £11,000 annually. One of the professors was to act as principal, with a liberal addition to his salary.

An uniform low rate of fees—a little less than £5 a year—was recommended; a scheme of scholarships and honours was proposed; diplomas were to be granted as already obtained in the medical branch; and the Council recommended an immediate commencement with the agency then at its disposal.

The sanction to this scheme came on the 10th April, 1854—three months before the date of the dispatch of the 19th July in the same year—of the intention even of which nothing was publicly known in India.

Mr. Secretary Beadon, in his communication to the Council, stated that "his Lordship had read with the highest interest and satisfaction the admirable letter in which the Council have submitted their proposal regarding this college, and he has desired me to offer to the Council his acknowledgments of the ability and lucid completeness with which they have interpreted and embodied the views of the Government on this important subject. To the Council's scheme, as a whole, the Governor is happy to give a prompt and full consent." The introduction of part of the scheme during the next vacation was sanctioned, but the formal declaration of the new constitution was postponed until it had received the approval of the Hon. Court of Directors, which his Lordship hoped would not be withheld or long delayed.

The proposal appears to have been submitted to the Home Government in a letter dated 5th May, 1854, two months before the date of the education dispatch of July. The answer from England was dated 13th of September, in 1854, two months after the dispatch. The two communications had crossed on the road, but the Presidency College was a *fait accompli*.

The Court of Directors expressed much satisfaction in approving the main features of the scheme, and inserted a few points which required to be borne in mind, in order that it might harmonise with the general dispatch of July 19th, sanctioning, among other things, the creation of universities in India.

The chief of the points was the withholding sanction to the granting of degrees and diplomas, which was to be confined to the University, not organised until 1857, three years subsequently.

The dispatch concluded with considering that great credit was due to the Council of Education for the clear and practical scheme prepared by them, from which great benefit was anticipated.

I have been thus particular in recording the leading facts connected with the establishment of what was the design and intention of a teaching university in Calcutta, because my share of it was my last work connected with education in Bengal, as it was likewise the last great work of the Council of Education itself, as an independent body. It also proves that a practical working scheme of university education was not only projected and elaborated, but was in effective although partial operation, even before the formal sanction to the creation of such institutions was made known in India.

The Mudrissa, or Mahommedan College of Calcutta.

Whilst engaged in considering the question of the Hindu College as an institution exclusively devoted to the education of Hindus, the Council of Education also examined into the question of the education of the Mahommedans of Calcutta in the college established by Warren Hastings in 1785. Detailed information was collected regarding it, from which it appeared that the English department, established in 1829, had been an entire and somewhat costly failure; and I was directed to inquire particularly into the causes of the failure, when I unfortunately fell sick, and was absent from my duties for some months. On my return I found that an attempt on the part of a new principal, Dr. Sprenger, to introduce reforms in the Arabic Department on his own authority, caused an outbreak among the students, which was inquired into by a committee of the Council of Education, when grave and serious abuses were found to exist, which necessitated a further and more general inquiry into all the departments of the institution. The chief abuse detected was that it had become, to a great extent, a place for the performance of religious observances by the Soonie sect of the Mahommedans. All these disciplinary matters were set right without any permanent ill-effect.

Dr. Sprenger was then again called upon to furnish a report on the general re-organisation of the college, and this report was submitted in 1852. In it the learned Principal suggested three leading schemes of reform, all more or less Oriental in character, which

were considered carefully by the Council. In the course of circulation of the papers, Sir Cecil Beadon, then a member of the Council, in an able and argumentative minute, suggested, as an amendment to the schemes proposed, that the study of Arabic should be confined to law and literature; that Persian should be introduced as an accomplishment, as well as a means of inducing Mahommedans to send their children early to school; that a higher standard of English should be attained, upon the plan pursued in the Hindu College; that Bengali should be the vernacular tongue cultivated in Bengal, for Mahommedans as well as for Hindus; and that a uniform schooling fee of one rupee should be levied on all pupils entering the Mudrissa.

Sir Frederick Halliday, Messrs. J. R. Colvin, Seton-Karr and J. P. Grant, and several other members, also recorded minutes on the subject, and after a careful consideration of the whole matter, a project of reform was submitted to the Government, when I had visited the North-Western Provinces, where I was deputed to examine into the education of Mahommedans, in the schools aud colleges under the Lieutenant-Governors of these provinces. The net result of my examination was, that in the way of education in English, little more had been accomplished at Delhi, Agra, and Bareilly than in the Calcutta Mudrissa, and that there was a general failure in the Upper Provinces also of the inducements afforded to Mahommedans to study the English language and literature in Government institutions freely open to all classes.

The basis of the Council's scheme was to place the institution, *mutatis mutandis*, upon the footing of all the other colleges in Bengal, with respect to the study of English; in fact, to give a good, sound English education, and to restrict the study of Arabic to its relation to Arabic literature and law, to stop the study of Persian, and thus eliminate entirely the semi-religious character which had been improperly given to the college.

All the documents above referred to were published in the appendices to my letter as executive officer of the Council, No. 1348, dated August, 1858, and are contained in No. XIV. of "Selections from the Records of the Bengal Government," already referred to.

The whole question was so complicated and difficult that the solution of it was specially referred to the president, Sir James Colvile, and myself, to elaborate a workable scheme for presentation to the Council and the Gover[n]ment. Our respective shares in this work a[re] recorded by the president in his Minute of t[he] 6th Sept., 1852.*

In an address presented to me by the leadi[ng] Mahommedans of Lower Bengal on my resig[n]ing the Indian service in 1870, occur t[he] following words:—

"You have taken the most sensible interest in t[he] affairs of the Mudrissa, the college designed b[y] Warren Hastings for the education of Mahommedan[s] which has for a series of years been in a state [of] inefficiency, as unsatisfactory to the Government [as] to the class for whose special benefit it was founde[d] at a large expenditure of public revenue.

"We cannot forget that, owing in a considerab[le] degree to your matured connsel, the Government i[n] 1853 designed an elaborate and effective plan of re[-]organisation. Had this plan been fully carried ou[t] the institution would have thoroughly satisfied thos[e] for whom it was designed, and we have no hesitatio[n] in expressing our conviction that had you continue[d] in your position, the Mudrissa would have partic[i]pated in the course of improvement which has visite[d] all other educational institutions in the province."

I stated in reply that—

"You are right in supposing that I have alway[s] taken a deep personal interest in the Mahommeda[n] community of Bengal. I should indeed be ungratefu[l] if I had not made the best return I could for th[e] kindness I have received from, and the confidenc[e] placed in me, by the generation which has nearl[y] passed away, but of which I rejoice still to see amon[g] you such representatives as my old and esteeme[d] friend Mouluvee Abdul Bari, for many years Cazi o[f] Calcutta.

"The friendship of such of my grandfather's friend[s] as were still alive was of much service to me in m[y] official relations with the Calcutta Mudrussa, as wel[l] as during the time I was in charge of that seat o[f] learning, between the departure of Colonel Ouseley and the arrival of the late General Riley.

"The mention of my connection with the Mudruss[a] of Warren Hastings brings me naturally to that part of your address which refers to the scheme of improvement projected many years ago.

"The chief merit of that scheme belongs to the late Mr. J. R. Colvin, a learned man and a large-hearted ruler, who died at Agra as Lieutenant-Governor of the North-West Provinces.

"It is true that I assisted at the deliberations connected with it, but my share of the work was confined to being the exponent of the results arrived at by Mr. Colvin, in conference with the learned Mahommedans of Calcutta.

"Of the present state of the Mudrissa it would

* Selections from the Records of the Government of Bengal, No. XIV., p. xxxiv. Appendix No. V.

not be becoming in me to speak, even if I were fully acquainted with it, which I am not; but of one thing I can venture to assure you in all sincerity—I mean my thorough belief in the desire of the Government to fulfil the intentions of the founders of the Mudrissa, and to afford to the Mahommedans of Bengal every advantage in the way of education, in equal measure to that which is so liberally extended to all other classes of your countrymen.

"As time runs on, knowledge increases, and the moral and material improvement of a nation advances, the character of its institutions must change, to place them in harmony with the altered circumstances inseparable from all progress.

"In adapting the Mudrissa to the changes which the establishment of universities in India may render necessary, I feel assured that due regard will be paid to the cultivation of your classical languages, and to the study of those special branches of knowledge which are cherished and revered by you as Mahommedans.

"Your co-religionists, gentlemen, are both readers and writers of history, and some of their contributions to this department of literature are monuments of industry and ability.

"If, then, you will study ancient and modern history with the critical discernment which characterises your best writers on the subject, you will surely perceive that the world has not yet seen or known a government more earnestly and honestly desirous of consulting the wishes and respecting the religious feelings of the people committed to their charge, than the Imperial and Local Governments of India.

"But have you, my dear friends, been quite true to yourselves in this important matter of education? Have you not allowed the astute and quick-witted Hindus to outrun you in the race for the prizes which are open to all, in the intellectual competition of the times in which we live.

"From my personal knowledge of many amongst you, whose careers I have watched since they were small boys in the Calcutta and Hooghly Mudrissas, I am satisfied that you possess a quickness of perception, a power of acquiring and applying knowledge, and earnest determination to succeed, sufficient to place you in the front ranks of your countrymen, of whatever creed, denomination, or province.

"Why should not a learned Mahommedan be a Judge of the High Court? Or your co-religionists occupy positions of honour, trust, and emolument, from the Council chamber downwards? You possess all the qualities and endowments required to succeed. You have only to travel the road which leads to success.

"I hope to hear of your taking a leading part in the public affairs of your country in all those paths which are freely opened to you, and I am satisfied that, as education spreads among you, and the wise and beneficent policy of the British Government is more widely known and understood, Her Majesty, our gracious and illustrious Sovereign, will not possess in all her wide dominions a more loyal, learned, and contented body of subjects than will be found in the ranks of the Mahommedans of Hindustan."

Since that time a considerable advance in the education of Mahommedans in all parts of India appears to have taken place, and the reproach as to indifference to the study of English has thereby been to some extent removed.

VII.—The Educational Dispatch of July 19, 1854.

I now come to my last head—the Dispatch of July 19, 1854, which was hailed with satisfrction by all parties in India, and is rightly regarded as the Magna Charta of education in that country. With the creation of a special Education Department, the sanction of grants in aid, and similar matters, I do not propose to deal. My purpose is strictly confined to the sanction given to the creation of universities, which is the leading feature of that great measure.

From various sources of information which had reached England as to the advanced state of education in India, and particularly from the periodical reports of the different Councils and Boards of Education, as well as from the evidence taken before the Committees of both Houses of Parliament on Indian affairs, which gave similar information on the subject respecting institutions not in connection with the Government, the Court of Directors arrived at the conclusion that they were then in a position to decide on the mode in which the assistance of the Government should be afforded to the more extended and systematic promotion of general education in India, and of the measures which should at once be adopted to that end.

They emphatically declared that the education they desired to see extended in India is that which had for its object the diffusion of the improved arts, science, philosophy, and literature of Europe—without disturbing such aid as was already given to the study of Sanscrit, Arabic, and Persian, for historical and antiquarian purposes, and the critical cultivation and improvement of the vernacular dialects derived from them. In this it merely affirmed the action taken in the Bengal Presidency, at all events since the introduction of English as the standard of public instruction.

After dealing with various other matters of more or less importance, the dispatch came to

the subject of my paper. It stated that "some years ago we declined to accede to a proposal made by the Council of Education, and transmitted to us by your Government, for the institution of a university in Calcutta. The rapid spread of a liberal education among the natives of India since that time, the high attainments shown by the native candidates for Government scholarships, and by native students in private institutions, the success of the medical colleges, and the requirements of an increasing European and Anglo-Indian population, shows that the time has now arrived for the establishment of universities in India."

This is certainly not a strictly accurate statement as respects the state of education in the Government institutions in Lower Bengal, and in Calcutta in particular, which were under my executive charge in the whole of that time, and had made no advance whatever, as the printed annual reports of the Council of Education show. Bengal was quite as ready for universities in 1845 as it was in 1854, and this was the opinion of those best able to judge of the matter at both periods.

The dispatch goes on to concur in the proposal of the Council of Education as to the form, government, and functions of the proposed university, which was based on that of the corresponding institution in London.

The examinations for degrees were not to include any subjects connected with religion, and affiliated institutions might be under the management of persons of every variety of religious persuasion, which in India would include institutions conducted by all denominations of Christians, Hindus, Mahomedans, Parsees, Sikhs, Buddhists, Jains, or any other religious persuasions, if they were found to afford the requisite course of study, and they could be depended upon for proper certificates of conduct.

In the constitution of the Senate, after providing for the Chancellor and Vice-chancellor—

"We propose to avail ourselves of the services of the existing Council of Education at Calcutta, and Board of Education at Bombay, to mark our sense of the exertions which they have made in the furtherance of Education, and to profit by their past experience of the subject. We propose, therefore, that the Council of Education at Calcutta, and the Board of Education at Bombay, with some additional members to be nominated by the Government, shall constitute the Senate of the university at each of the Presidencies.

"The additional members shall be so selected as to give to all those who represent the different systems of education which will be carried on in the affiliated institutions—including natives of India, who possess the confidence of the native community—a fair voice in the senate. We are led to make these remarks, as we observe that the plan of the Council of Education in 1845, for the constitution of the senate of the proposed Calcutta University, was not sufficiently comprehensive."

This is quite true, but the omission was intentional, as it was considered to be *ultra vires*, and exercising a function of the Government which the Council did not possess. Their scheme was a mere outline, which would have undoubtedly expanded in the direction above noted, had it been sanctioned at the time.

It was also intended by the Council to have graded the schools and colleges in Bengal, so as to bring all into relation with the university from the lowest to the highest, and thus to exercise a beneficial influence among all classes of the people, as shadowed in section 63 of the dispatch, and as contemplated by Lord Hardinge's resolution of October, 1844.

Here, so far as the origin of universities in India is concerned, my story might fitly have ended, had not a writer of great authority and learning attempted to prove that the whole credit of this, the greatest step in advance taken by the British Government, was due to three gentlemen whom he names, and to them alone. Lest I should in any way misunderstand, and thereby misrepresent, his contention, I will produce it in his own words.

Dr. George Smith, in his charming and genial biography of Dr. John Wilson, of Bombay, in writing of the Educational Dispatch of 1854, says:—

"The catholic system of public instruction which was legislatively established in 1857, was directly the work of the missionary party. It was, and is still, the result of a compromise between the Government, as a secular State, and all non-government or proselytising bodies, heathen and Christian, who claimed to give a sound education to the people in addition to any religious instruction of which the State, as the ruler of millions of men of different creeds, cults, and customs, can officially take no cognisance at this stage. The State, however, does not ignore natural or even revealed religion. But calling universities into existence, and placing them under an executive body largely separate from itself, the Government at once put the higher education in its proper place of self-developing independence, and it provides bodies competent to examine of all the great religions as they appear in the literature, the philosophy, the history, the laws, and in fact, the

.cred books of each. Questions long discussed in ıe Christian Parliament of the mother country, and ɔt concluded even yet (1878) for Ireland, were ı 1857, under far more conflicting circumstances, ettled for ever on the true basis of complete toleraon and fearless confidence in its ultimate triumph; nd the men who brought that about were John Iarshman, Alexander Duff, and John Wilson." *

"*Splendide Audax*," in which the perfervid eal of the biographer appears to me to have ost sight of the judicial impartiality of the ıistorian.

In the dispatch itself there is no indication ɔf any change in the attitude of the Government towards the religious bodies above referred to, or the giving of religious instruction ın the Government institutions. The Bible had long been in the libraries of the Government Colleges. In the Hindu College at an early period, when the highest classes were examined in his presence, in some passages of Milton, Prince Waldemar of Prussia, with whom I was at the time, asked every student in turn if he was acquainted with the Bible: each of them answered that he had one of his own, and studied it in order to understand those parts of the "Paradise Lost" which need such knowledge for their correct apprehension. But that, in sanctioning the admission to the Senate of missionaries and others representing educational institutions, strictly in their secular relations, there was a recognition of national or revealed religion, or any extension of the toleration always exercised in the relations of the State to such matters, I fail altogether to see or understand. There can be no real honour to the admirable men mentioned in crediting them exclusively with that which they only share with very many equally distinguished workers in the same field, viz., the general advance of secular education in India, in which they assuredly did not occupy the exclusive place assigned to them. With the original university scheme of the Council of Education, in which the catholicity of public instruction above referred to is contained, and which is afterwards credited to the missionary body, the only one who had anything to say to it was my revered friend, Dr. Duff; and in considering that scheme with him, which I did in detail, when it was completely settled by myself, he expressed the most cordial approval. His relation to it is incorrectly stated in his biography.

I have only noticed such statements as those above referred to, that they may not pass into history without an authoritative contradiction, for whatever that may be worth. And now, fairly faced, what is the real origin of Universities in India?

In science, the originator of any new fact or discovery is he who first works it out in his study or laboratory, and conclusively establishes its scientific truth, not he who applies it to the practical purposes of life. I witnessed a curious illustration of this when walking, a few years since, in the neighbourhood of Berlin, with one of the most distinguished chemists of the time, who had made an original discovery of great economic value. He lived in a modest villa; he had not patented his discovery, as he told me that science was for the benefit of all mankind, and its facts and discoveries, whenever they tend to the promotion of human happiness, should be at once made known as widely as possible, without reference to personal or pecuniary considerations.

A short distance from his villa we came upon a princely residence in course of construction, and I asked him to whom it belonged. He replied, "To the man who has realised a princely fortune by the application of my discovery—and here he comes, so let me introduce you to him." This successful manufacturer was popularly regarded as the discoverer of the article by means of which his fortune was created; the philosopher is known only to the few of his class.

In legislation it is the same. The passing of a law is based upon the establishment of its need, which has frequently been the patient labour of years of discussion, in the course of which the original workers have disappeared, and too often been forgotten or ignored; yet to them does the chief credit of the work belong, as the originators of the law.

The brilliant and learned author of the "New Leaven in the India of the Queen," with an eloquence and depth of knowledge and research as well as wonderful power of expression which I am altogether incapable of imitating, attributes the great awakening which he apparently believes to have arisen in that vast and singularly interesting country to be due in a great measure, if not entirely, to the dispatch of 1854, until which the official conscience had remained inert both at home and abroad. I am unable to admit the historical accuracy of this view, or of the pathetic preamble which preceded its utterance. I submit that the official conscience, in Bengal at all events, was thoroughly awakened

* Smith's "Life of Dr. John Wilson," p. 529.

in 1835, when the education afforded by the State sprang into new life at once, and the impulse then given had continued unbroken up to the time it was personally known to me, when I left India in 1870.

It astonished Lord Macaulay himself. The pioneers in that great work, Horace Wilson, Ryan, Cameron, Bethune, Colvile, Beadon, J. P. Grant, Seton-Karr, and others of the Council of Education, with several of the professors in the colleges, and many of the civilians who managed the Zillah schools, deserve some more remembrance of them and their work than is usually accorded to them. Two days before the close of his honoured and valued life, Mr. Bethune, at whose bedside I was watching, and whose eyes I closed in their eternal sleep, asked me how long he had to live. "Don't conceal it from me," he said, "as I wish to complete the last work of my life." When I mentioned to him that I could only measure it by hours, he called for his cheque-book, drew a cheque for a very large amount, and bid me hasten to realise it, and to keep it in my custody until he had passed away, for the benefit of the female school he had established. This was done.

His address to the students of the Kishnaghur College, in which he dwelt upon the relative and absolute value of science and literature as instruments of instruction, was a master-piece of eloquence and profound acquaintance with the work he had to perform. It is in the published records of the Council of Education.

I was his executor, and found that the whole of his large official income in India was spent in the country, and chiefly in good works, of which the foundation of the female school which bears his name, was the chief.

Again, no man deserves more to live in the history of benefactors of his country than Pundit Madu Sudan Gupta, of the Medical College of Calcutta, the first Hindu of high caste who dissected the human body in public, a feat of courage and humanity impossible to surpass, when the conditions of Hindu life are considered.

Why are all such men either altogether omitted in works professing to be history, or dismissed with some general expression of approval which had better not have been uttered. I also am not disposed to minimise or to undervalue missionary work, but I am as little disposed to place it in the fore front of Indian history, or to attribute to it greater value than its advocates can rightly lay claim to, in the exceptionally difficult problem of the government, of the most heterogenous ethnical elements, and greatest numbers that have ever been brought under the sceptre of a single sovereign.

II.

The second subject of my paper is the progress of universities in India.

On this I am most sorry to be obliged to confess that I have very little to say, for I have been unable to find any reliable authorities from which I could gather information of the progress of each university from year to year, in the manner that progress could be distinctly traced in the old records of the Education Department of Bengal, prior to 1854. In 1852, I was deputed to visit and report upon the question of the education of Mahommedans in particular in the North-Western Provinces of the Bengal Presidency, and prior to that I conducted a confidential inquiry into the education of the Madras Presidency for Lord Hardinge, while the Government of that Presidency was in the hands of the Marquis of Tweeddale.

On both I furnished the reports required from me, but they were during the ante-university time, and have of necessity no reference to it. Beyond the above I have no personal knowledge of education in any other part of India than Lower Bengal.

It is, I think, much to be regretted that the subject of the *status quo* of the existing universities of India was not referred to Sir William Hunter's committee, as in their scheme of universities, the Council of Education in their original plan, and in the subsequent organisation in the form of the Presidency College of a teaching university, looked greatly upon the universities as primary and powerful factors in the improvement of education generally, from the most humble village school, or patshala, to the Anglo-vernacular district schools, and the colleges—which were really high schools of the first class—up to the technical institutions for teaching medicine and civil engineering. We should then have had an authoritative analysis of the work done by, and progress of, the universities up to the date of their report. I do not deem it worth while to put together the *disjecta membra* of the scanty and fragmentary information which alone I have been able to collect.

I cannot think that one of the chief objects of the institution of universities has been ful-

filled, when such a voluminous report as that contained in the proceedings of the Indian Education Commission of 1883 was considered necessary, after the existence of the institutions since 1857, more than a third of a century. I have not had time to look into this report, but so far as a glance at its contents can indicate, it seems to be a mine of wealth, admirably arranged, on the subject, which I may probably explore at some future time, when I have the requisite leisure, and am able to pay a visit to India and go over the whole ground, and witness for myself the enormous changes that must have taken place since I quitted the Council of Education in 1854.

In an official note on the University of Calcutta in 1865-6, it appears that in the ten years from 1857-1866 there entered as candidates for examination 10,652 students, of whom less than one half—4,705—only passed. Of these 243 obtained the degree of B.A., 35 of M.A., 38 of licentiates in law, and 107 of B.L. For the license in medicine, 436 presented themselves for examination, of whom 372 passed the first and second examinations; 7 were examined for the degree of Bachelor of Medicine, and all passed the first examination only. None were subjected to the second examination. Of 6 examined for the degree of M.D., 4 obtained it. In civil engineering, 52 were examined, and 27 passed as licentiates.

Without examining the statistics I am unable to understand or explain the significance of these figures; and I have not had time, nor could I find the materials, to make the examination. Changes appear to have been made, apparently, in both the standards and subjects of examination, and in the rules for affiliation; but to consider and explain these would need a volume rather than a paper to itself. It would also necessitate very careful study of all the published documents concerning them, of which there is not, I believe, a complete series in England.

The late Sir Henry Maine, with the command of all the resources of the India Office, and his own four years' experience of the office of Vice-Chancellor of the Calcutta University, could only find that 5,000 students had obtained degrees between 1864 and 1883, both inclusive; and, assuming that everyone who had taken a bachelor's degree is sufficiently educated to have valuable ideas in politics, and for the purpose of including all who in any sense can be called educated men, he multiplied 5,000 by five, and obtained 25,000, as the proportion of the educated to the rest of the population—reckoned as 250,000,000. There are so many fallacies underlying this mode of calculation, and the method adopted is so entirely inapplicable as a test of the progress of universities, that I should not have quoted these figures but for the deservedly high reputation and authority of the gifted and talented author of "The Village Communities of India" and "Ancient Law."

I, myself, ascertained from figures carefully collected and scrutinised in the jails of Bengal whilst they were under my charge, that the absolutely ignorant and uninstructed adult members of the criminal population, amongst more than a million of those incarcerated, was 93 per cent. and that of the remainder only 3 per cent. were even fairly educated for their respective positions in life. This, I then believed to represent a fair average of the same fact among the adult population of Lower Bengal, with the 100,000 village schools discovered by Mr. Adam, in his celebrated report on indigenous education, after an exhaustive inquiry made by direction of Lord William Bentinck. At that time no numbering of the people had taken place, and about 30,000,000 was roughly assumed as the strength of the people in that province—how singularly erroneous we now know.

In Mr. Howell's able note on education throughout India in 1886-87, he states that Bengal will be found, by the Standard of Statistics, to keep its prominent position, both in regard to the facilities for higher education of all kinds which it offers, and the appreciation shown for such education by the natives. This was evidenced from the fact that of the 1,350 candidates for university entrance examinations, 1,147 were from Bengal alone, and of these 561 were successful, of the total 638 successful candidates. In the first arts examination, Bengal sent in 120 successful candidates out of 131; in the B.A. examination 58 out of 60; and in the M.A. examination 18 out of 22. In Bengal, the law classes of the Presidency and High Colleges were not only self-supporting, but yielded a considerable surplus; and the Medical College, especially in its vernacular classes, was highly popular.

In the same year, the late Sir Alexander Grant, a very competent authority, said that he had complete faith in the standards of the university (of Bombay) and that as the departmental schools now subordinated so as to lead up to the university standards, he considered each school satisfactory in accordance as it

fulfils its proper and defined functions. The same view, Mr. Howell states, appeared to be accepted by the Director of Public Instruction in Madras.

This valuable note considers other very important questions connected with the progress of the work of the universities, which are deserving of careful study. It is to be regretted that such masterly and careful reviews of the progress of education in India, as a whole, are not repeated at quinquennial periods, as I recommended long ago with respect to judicial and prison statistics and proceedings. The figures for short periods, collected over limited areas, and covering only more or less exceptional circumstances, are of comparatively little value as tests of progress, as every one who has studied political arithmetic, and can handle correctly figures as exponents of facts, knows. I prepared one such report of the prison department of Bengal before I left India, and it was published by the Government of that province. I am not aware that the plan was continued.

There is one singular circumstance mentioned by Sir Alexander Grant, in his report on education in Bombay, which is quoted by Mr. Howell. It is as follows :—

"The leading fact which, I think, discloses itself in comparing the universities of Calcutta and Bombay, and which is very interesting, is that there is a difference of kind between the two universities corresponding to the difference between Cambridge and Oxford. The Calcutta University has been, I believe, chiefly managed by Cambridge men, and the Bombay University has certainly taken its directions from a preponderance of Oxford men among its founders. The result of this difference of directions has been, amongst other things, to give a preponderance to mathematical and physical studies in Calcutta, and to historical and philosophical studies in Bombay. The effect of the different spirit of the two universities upon the mind of Eastern and Western India will remain to be seen in the future; but, as yet, I am humbly of opinion, that neither university has any very great cause for self-glorification. We are at best, it seems to me, in complete infancy, and have much in our development that requires careful attention."

This is a line of inquiry deserving of very careful study and observation in regulating the progress of all the universities in India, and adapting their standards and methods to the ethnological peculiarities of the different races to whom they are applied. It is somewhat singular that some years previously, prior to the establishment of universities, the Council of Education was charged with discouraging literature, and leaning too much to the study of science, in consequence of the personal predilections of the then president, Mr. Bethune, for mathematics as a mental training to logic and metaphysics, in the instruction of Bengalis. That accomplished scholar, in a singularly able address to the students of the Kishnaghur College, pointed out clearly the functions which such studies are respectively intended to fulfil, and how this might best be fitted to correct the defects and develop the virtues in the character of the Bengalis, and in the training of their undoubted high intellectual powers.

Their hereditary mental bias is for logic and metaphysics, and they are much given to the realisation of Menage's definition of the former, described as the "art of talking unintelligibly, of things of which they are ignorant." Mathematics and physics are, I think, considered to be the natural correctives of this defect, when they are rightly taught.

This also seems to me to show that, in determining the course of study best adapted for the natives of the different provinces in which universities have been established, due regard should be paid to the ethnological character of each, and that the uniform systems adopted have been out of place. This, however, opens a very large and extensively important question which scarcely falls within the purport of my paper.

III.—Influence of Universities in India.

Opinions have differed and will continue to differ as to the influence of this branch of the educational system of India, expanded and extended into a national system by the dispatch of 1854.

Sir Henry Maine, tracing back to the effects produced in 1835 by the adoption of English as the standard of public instruction in all Government colleges, and in the secondary schools of the country, was of opinion that it had produced many grave and unlooked-for results. The downward filtration theory he dismissed as having failed to exercise any influence on purely vernacular education. Of the value of European science to the cultivated and instructed classes in some of the populations, he considered that there could be no question whatever, "but where the Indian intellect had been trained at all before the establishment of the British Indian empire, it stood in need, before anything else, of stricter criteria of truth. It required a treatment to

harden and brace up, and scientific teaching was exactly the tonic which its infirmities called for."

To the study of English literature he attributed the danger to the State which he believed to exist. To the party politics with which that literature was saturated, by its untruthful, exaggerated, or erroneous views, he believed the minds of the educated Indians of this day to be deeply influenced; but I doubt much if the works and speeches of Burke and Sheridan, Fox and Francis, had much, if anything, to say to it. Sir H. Maine neither spoke nor understood Bengali or Hindustani sufficiently to hold personal commnnication with any of the higher order of natives who were unacquainted with English, and may have obtained his information from graduates of the Calcutta University, comparatively few of whom are really representative men. The frothy declamations of the most noisy among them, and the treasonable trash which disgraces the less worthy Bengali journals, can scarcely become a source of public danger to the empire so long as their opinions are practically confined to themselves, whom alone they represent.

The sentiments expressed by Lord Metcalfe, when he removed the fetters of the Indian Press in 1835, are even more true of India now than they were then, when the supposed dangers of that measure were viewed by some with great apprehension. He said that "the Act evinced to the world that the Government of the company desired no concealment, that it was happy to have the most minute particulars of its Indian administration scrutinised, and displayed to the gaze of the universe, that it sought information and instruction wherever they could be found, and did not wish to rule India as a conquered, ignorant, and enslaved, but as a cherished, enlightened, and free country." The action of this enlightened and far-seeing statesman has been shown to have been sound by the absence of the dangers contemplated, during the half century which has since elapsed.

During the Parliamentary inquiry regarding the renewal of the Company's Charter in 1853, Sir F. J. Halliday was asked if there were any grounds for the supposition that the spread of education in India was doing injury to the British Government. He answered—"None whatever; on the contrary, it must assist the Government. The educated classes, I think, feel themselves—and must feel themselves—more bound to us, and as having more in common with us, than with their uneducated countrymen, apart from the general fact that it is more easy to govern a people who have acquired a knowledge of good and evil in Government, than it is to govern them in utter ignorance; and, on the whole, popular knowledge is a safer thing to deal with than popular ignorance."

The question is specifically referred to in a dispatch, dated 7th April, 1859, from the Secretary of State for India, which begins with the statement, "That the time had arrived when some examination might be instituted into the operation of measures on a more extensive scale for promoting education in India. Such an examination seems more especially required since the measures, and particularly the more recent measures, of Government for the promotion of education, have been alleged to be among the causes which have brought about the recent outbreak in the army of Bengal, and the disquietude and apprehension which are believed to have prevailed in some portions of her Majesty's Indian territories."

The establishment of universities was declared not to be a measure calculated, *per se*, to excite apprehensions in the native mind. It did not, in fact, bring any new principle into operation, being little more than an expansion of the arrangements which had been for many years in operation, for testing the progress and attainments of the young men educated in the colleges and more advanced schools. No teaching of any sort of religion was proposed to be given in connection with the universities, and on the only point in connection with the examination of degrees, in respect to which any doubt might have arisen, viz., that of reckoning the marks obtained by those candidates for honours who might voluntarily submit themselves to examination in Paley's "Evidences of Christianity," and Butler's "Analogy of Religion," the home authorities determined that such examination should not be allowed, and thus removed all possible ground of misapprehension.

The matter evidently excited some apprehension at home, since the dispatch ended as follows:—

"In conclusion, I have to call your attention to the question referred to at the commencement of this dispatch, viz., that of the connection between the recent disturbances in India and the measures in progress for the prosecution of education. It is only in the reports of a few of the officers of the Bengal Government that any official information is afforded

on the points, and in them the evidence amounts to little, and is confined to Behar."

And it ends with stating—

"That it is impossible to point out conclusions on information so manifestly insufficient as that which her Majesty's Government possess, and they have, therefore, to commend this matter to your careful consideration."

It is obvious that measures, however good in themselves, must fail if unsuited to those for whose benefit they are intended; and it seems important, therefore, to learn whether any of the measures taken by Government in recent years to promote the education of the natives of India have been such as to afford just ground for suspicion or alarm; whether, notwithstanding the absence of any just cause of alarm, there has in fact existed a misunderstanding of the intentions of Government with regard to their measures which excited this apprehension, however unfounded; and whether any and what alterations of existing arrangements can be devised, by which, without drawing back from the great duty, so deliberately affirmed in the dispatch of the 19th July, 1854, of raising the moral, intellectual, and physical condition of her Majesty's subjects in India, by means of improved and extended facilities of education, the risk of this apprehension may be lessened, and the minds of the people may be set at rest.

How such an utterly baseless report could have arisen I know not, for a very large number of the mutineers passed through my hands on their way to the Andaman Islands, when the prisons of Bengal were under my charge, and I inquired from some of the leading men among them to what the revolt was really due. They attributed it entirely to the greased cartridges, an honest belief in the minds of very many that their religion was in danger, and a conviction that the British Government was too weak to deal with it effectively from the extraordinary and, to them, unintelligible leniency with which the 19th Regiment were treated in their disbandment, and being allowed to wander through India as propagandists. No mention whatever was made of education as an instrument of surreptitious conversion, although many of them spoke with the bitterest contempt of the elevated position obtained by a race whom they heartily despised, through the medium of education.

The views of the Home Government wer[e] emphasised in another dispatch of earlier dat[e] (April, 1858). They said:—

"It is the duty of all public servants to carry ou[t] with good faith the declared intentions of th[e] Government under which they act. There is n[o] safety for a State if over-zealous individuals be per[-]mitted, in the execution of the duties entrusted t[o] them, to substitute their own policy for that of th[e] Government.

"A Government must not be supposed to say on[e] thing and to mean another.

"The Government will adhere in good faith to th[e] ancient policy of perfect neutrality in matters affect[-]ing the religion of the people of India, and we mus[t] caution all those in authority under it not to afford by their conduct, the least colour to the suspicion that that policy has undergone, or will undergo, an[y] change.

"It is perilous for men in authority to do as indi[-]viduals that which they officially condemn. The rea[l] intention of the Government will be inferred from their Acts, and they may unwittingly expose it t[o] the greatest of all dangers—that of being regarded with general distrust by the people."

It would be difficult to enunciate a policy with greater clearness, emphasis, and precision. Nearly 30 years have elapsed since those words of wisdom were written. The result has proved that the good faith of the Government is nowhere doubted, and that the extended system of public instruction inaugurated authoritatively in 1854, is bearing good fruit in the extraordinary spread of education in every province of India.

That it will in time result in fitting the country for representative institutions, and self-supporting colleges and schools, appears to me not to admit of doubt; but to attempt to introduce them prematurely, before either the agents or the instruments exist, will, I think, put back the hands of the clock, check progress, and end in most undesirable and disastrous failure. Things move slowly in so eminently conservative a country as India. To expect rapid results from the influence of universities in that country is unreasonable, and doomed to certain disappointment. I confess that I do not myself regard with any apprehension the discussions of the National Indian Congress and similar bodies. It is but natural that the educated natives of India should desire to enjoy a larger share in the government of their country than they now possess. The more they discuss and consider the question, however, and study the history of the gradual grant of liberal institutions in

iore advanced countries, the more thoroughly ·ill they rise to a knowledge of its inherent ifficulties, and the danger of introducing uch institutions, particularly into India, as ·ill peril the stability of the Empire, and be ttended with disastrous results to themselves.

The idle talk and trashy treason which many ere regard with dread, and to which they ttach far more importance than they deserve, re not, in my opinion, due to any cause conected with the establishment of universities n India, or to the study of the literature conlemned by Sir Henry Maine. The real mishief, if there be any in them, seems to me to e due to the misdirected benevolence, and omewhat absurd coddling, with which the atives are treated in England, and the political ssociations which they form while here, whose iews they faithfully reproduce in India, vith sublime disregard of their utter inpplicability.

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The conclusions, then, which I draw from the rief narrative of each movement of progress which I have placed before you, seems to me o be that the great movement which culmiated and continued, but did not commence with the Charter of Indian Education in 1854, began with the establishment of the Hindu College in 1816; took its permanent form in 1835, by the introduction authoritatively of English as the medium and basis of teaching the literature and science of the Western world, the learned languages of the East being taught only for their historical and philological value; the establishment of the Medical College of Calcutta in the same year, in which a complete training in the art and science of medicine in their modern and most advanced forms, the earliest institution of the kind in Hindustan, and, I believe, in Asia; the abortive attempt, in 1844, of the Government of India to unite all the educational institutions, public and private, of the Presidency in a scheme of training public servants of all classes for the State, and thus to advance education generally; and the scheme of a university for Calcutta, strictly on the lines of the University of London, formulated by myself, approved and adopted by the Council of Education, of which I was a member, strongly supported by the Government of India, but rejected by the authorities in England as prematnre.

A second attempt was made by the Council in 1853 to accomplish the same end, in a different and, I believe, preferable manner, by the establishment of a teaching instead of a mere examining university, utilising for the purpose the principal college in the Presidency, which had unexpectedly come under the direct control of the State, and elaborating a scheme, complete in its outlines, to effect that object. The scheme preceded that of the following year, and the portion of it sanctioned by the Government of India was in effective operation before the receipt even of the dispatch, to which so much importance is rightly attached. Lord Dalhousie approved of the *entire scheme*, but doubted his power of carrying it into full effect without higher authority than his own. great as that was; hence the delay which eventuated in its supercession in the most important of its provisions—that of granting degrees.

You will perceive that in my narrative I have, as often as it admitted of it, used the *ipsissima verba* of the schemes to which I referred, as none of the abstracts which I have seen convey such an impression of them as to show their real purport. In this I am merely following the example of the publications of the personal memoirs and records which are reproduced to throw light upon the historical events to which they relate. They are rather *mémoires pour servir*, to secure more accuracy than history itself, and they embody the real purpose of all modern historical research and criticism.

I have no personal end or object to serve in my contention. My purpose is to secure historical accuracy regarding one of the most important events in the history of India, the ultimate result of which can, I think, be gauged with tolerable accuracy, even at this early period of the existence of universities in India.

I also desire to do justice to the labours of those of my fellow workers in this great task—most of whom have now passed away.

I maintain that the actual bringing about of universities in India was due to the Council of Education, and to that body alone, and that I have a right to claim, as my individual share, the paternity of the plan, and the initiative of the action. I by no means question the great part played in the advancement of higher or collegiate education, and the invaluable services rendered to civilisation and humanity, chiefly by other bodies, lay and clerical.

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a position which I am happy to see, she continues to maintain.

The views which I then entertained on the subject I still entertain. In 1851, the late Dr. Duff, under whose editorship I believe it then was, asked me to contribute an article to the *Calcutta Review*, on the best means of cultivating friendly intercourse between educated natives and the corresponding members of the European community. I must ask your indulgence in extracting from it the following passages :—

"Every step in the march of human progress is worthy of being recorded."

After referring briefly to the state in which Bengal was found by her present rulers, from which every effort was being made to raise her by missionary enterprise and education, I continued :—

"The mission of England in the East is the most glorious and the most sacred that has ever been entrusted by Divine Providence to a nation. Opinions may differ as to the most direct means of accomplishing the regeneration of a country so long steeped in the most concentrated bigotry and superstition. Yet all really liberal-minded men must allow that every species of knowledge that removes a prejudice, corrects an error, points out a fallacy, and teaches the straight path, even in the social relations and ordinary intercourse of the people, is a step in the right direction. The axe has been laid at the root and the tree must fall. The time and manner of its descent are not susceptible of exact solution, but the accomplishment of the event is as certain as the path of the sun through the heavens, or the advent of light and day upon the close of darkness and night.

"As in the natural, so in the moral revolution, the earliest dawn will be grey and indistinct; the rising of the sun of truth gradual—from the first faint blush of rosy morn to its full splendour and glory, when its noontide rays shall once again fall upon a happy, prosperous, and contented people; not in the sense attached to those terms in the early infancy of mankind, but in the literal meaning now belonging to them, when applied to a moral, religious, and educated nation. Scholastic discipline, and the didactic knowledge acquired within the walls of a school, may accomplish much, but these can scarcely, even in the most favourable circumstances, do more than lay the foundation. The elevation and adornment of the superstructure must always be the work of the individual himself.

"To prevent the effacing of the images impressed in the state of pupilage—to generate a taste for the cultivation of literature and science on their own account—and to impress on the minds of the educated youths who leave our institutions, a preference for pure and intellectual over sensual pursuits, and a thoughtful, determined, and inquiring spirit—can only be expected by improving their social condition, and affording them the means of keeping up, interchanging, and advancing their knowledge."

The home of the cultivated Hindu is a moral blank. His social circle is not hallowed by the pure and ennobling influences which can alone result from the presence of virtuous, educated, and accomplished women. From the light and cheerful spirit of the busy world without, he retreats to the gloom and soul-less influence of his household within. The prejudices of caste bind him in adamantine chains, which few have strength and resolution to break. His intercourse with other families is restricted by the same impenetrable barrier.

To discover, then, a neutral ground where all can meet on equal terms is an incalculable benefit to such a state of society. To accomplish this desirable end is a task of no small difficulty, where the elements of discord are many and strong, the bonds of union few and weak. The proverbial apathy of a naturally indolent constitution has to be stimulated to cause even the slightest physical exertion beyond the ordinary pale of a life of ease and repose. The *vis inertiæ* or power of resisting any change is developed in the highest degree in the Bengali.

"Among the means best fitted to change the undesirable conditions above stated, is, undoubtedly, the establishment of literary and scientific societies. The intellectual gladiatorship which this calls into being, and the generous spirit of harmless rivalry begotten by them at the most interesting and important period of life, cannot fail to produce a wholesome effect on the minds of the young, and to result, when properly conducted, in leaving lasting impressions of the healthful and invigorating influence of moral and mental pursuits.

"Such has been found to be their effect in developing the character and strengthening the power of reasoning of the high-born youths of our English universities.

"Like causes in all cases produce like effects. Whatever is true of Oxford, Cambridge, Edinburgh, and Dublin is equally true of Calcutta. There is probably less difference in the original mental constitution of various nations then most metaphysicians have imagined. At all events, in the power of acquiring knowledge, and the capacity to master the technical difficulties of the highest departments of abstract science, the Hindu has proved himself to be not a whit inferior to the best of his western contemporaries. Where he fails is in the subsequent application of his acquired information, and in the determined vigour with which the great battle of life is fought by his Anglo-Saxon

prototype, as contrasted with their predestinarian spirit with which he is content to sink, unshamed and insensible, into the most absolute state of degrading dependence."

I hold it to be one of the great functions of the Indian universities to correct all this, and I am happy to gather from the scanty information that I have been able to glean by those records which I have been able to consult, that it has not altogether been lost sight of.

And now before closing my remarks, I wish to pay a tribute of regard and affection to my friends the Bengalis, who have been somewhat roughly handled of late, not altogether justly, as I could show from my intimate knowledge of them when they were under my constant personal supervision for many years. Some thirty years of the most active period of my life were passed among them, and I am of opinion that in power of mind, in intellectual culture, in the strength of their domestic feeling, and in the possession of those qualities which are the foundation of true human greatness, they are entitled to a very high place in the scale of nations. As years roll by, by the action of university teaching and the healthy friction of public life, they are gradually fitted for representative institutions and self-government—which they certainly are not now, as shown by recent events, but which are bound to come. Whatever may be the future destined by Providence for Great Britain herself, there will be no event in her long and glorious annals that she will be able to look back upon with more pure unselfish feelings of satisfaction than the efforts to give to the people of India the liberty and the civilsation which have placed her in her present proud position.

I shall myself vanish permanently from public life in a few days, after nearly half a century of service, and as this will probably be my last public utterance, I must again crave your indulgence for the strongly personal character I have felt compelled to give to my contention. I am among the very few survivors of the Old Guard who fought the battle, and put our whole strength into the work of public instruction, in the ante-university period, without seeking any other reward than the consciousness of having done our duty to the best of our ability, and of having assisted chiefly in laying the deep, sure, and solid foundation upon which the University of Calcutta has been erected, which we were not permitted ourselves to build. You need not wonder, therefore, that I am tenacious of putting it fully and fairly upon the record before I pass away, and that I do so in the spirit which animated the celebrated body to which was apocryphally applied, but which is true of our actions, that "*La garde meurt, mais ne se rend pas.*"

DISCUSSION.

Sir JOSEPH FAYRER, K.C.S.I., F.R.S., said he was very glad to have been present on this occasion, though it was not pleasant to hear, as Dr. Mouat said, that it was to be his last public appearance. He was delighted to see him after 50 years of such service as few had rendered, with his eye still undimmed, and his natural forces unabated. He first met him in the year 1850 at Dacca, and he had been one of his most valued friends ever since. He knew none who had worked more zealously and earnestly, or with greater self-abnegation, and it had always been difficult to understand how such services had been so ill-requited, for surely no officer ever left India after such long service who had left his mark more thoroughly impressed upon it than Dr. Mouat, and as long as the English remained in India, and in every tradition of the work done during the past century, Dr. Mouat's name would stand prominent as a philanthropist, and as one who had done all that was possible to raise and develop, in the true sense of the term, the natives of India. What he had said about them was perfectly true. He (Sir Joseph Fayrer) also had studied them closely, having had a great deal to do with their education, though of a somewhat technical kind. He had had to study the course of these young men closely, knew them well, and had a great personal affection for them, but he thoroughly agreed with what Dr. Mouat had said, that the time had not yet come when that process of evolution which would surely bring them to much higher things, and which would fit them for all the most prominent situations had yet arrived. He had no desire whatever to detract from them—intellectually they were exceedingly keen and clever, they were capable of learning and doing, and as anxious to learn as most other people; but it was not possible, even with all that had been done by colleges and universities, to do in 100 years for an Oriental nation what had taken so many centuries for our own. That it would come in time he had no doubt, provided only that the scheme be carried on judiciously, and not forced forward too rapidly by that terrible system now at work, which was doing so much injury, by cramming and forcing the brains of young people, not leaving them any time to learn because they had to pass examinations. Such a system could not work well for a young nation just springing into activity and energy by the education it had received.

He had listened with a great deal of interest to the paper. He had watched the growth of the universities of India for some time, but during the thirteen or fourteen years in which he was closely associated with the University of Calcutta as an examiner and teacher, he had watched it with special interest. He was not prepared to offer any opinion on the arts or classical side, but of the scientific and technical education he could only speak favourably. The system of medical education, conducted in the University of Calcutta, was as good and sound as that given in any part of the world, and it was needless to tell any old Indians how much India was indebted to Dr. Mouat for what had been done in that direction. The Medical College owed its origin and much of its development to him. He was certain that, in connection with it, no name would be more cherished. He much regretted to hear that this was to be Dr. Mouat's farewell appearance, though he had known for some short time that he was about to terminate his second official career, which had been equally successful if not as important as the first. He did not believe the full importance of what he had done had ever been properly recognised.

Mr. W. S. SETON-KARR said he had listened with great pleasure to this admirable historical review of education in India, and should not diverge into any political speculations, although they were by no means ill-timed at present, as to the gradual advancement of the natives, and their being fit for self-government, or representative institutions. He should prefer to confine his remarks to some historical recollections which the paper had called up. He was much struck with what Dr. Mouat had said about the three men never to be mentioned without respect—John Marshman, Dr. Duff, and Dr. Wilson. Those names stood sufficiently high for their friends not to arrogate to them any more merit than they could properly claim. They each did excellent service, and Dr. Duff's name will always be recollected as that of the first missionary of the age; but it was hardly correct to say that the establishment of religious tolerance and the University system were due to them, and it was only right on Dr. Mouat's part to poiut out that it was he who first suggested the idea, and drew out the scheme of what were now the Universities of Calcutta and the other Presidencies. With regard to Dr. Duff, his memory carried him back to what the late Sir Charles Trevelyan had said, at the time of the great battle of the Pundits, when it seemed as if Orientalism was going to triumph over English literature, and there was very little doubt that Lord William Bentinck and Lord Macaulay would never have carried out their views with regard to English literature in the manifesto of 1835 without the aid of Dr. Duff. He recollected, also, the late Mr. Bethune, to whom Dr. Mouat alluded, describing the very first occasion on which a dead body was dissected by a Hindu. He had been told by eye-witnesses how Pundit Madu Sudan Gupta went in the presence of two or three professors into the hall, whilst the other native students, more timorous, or not so earnest, looked through the window from outside, and how some of them fled in terror when the knife was put into the dead body. However, from that day the process of scientific anatomy had been successfully pursued by many hundred Hindu students, and perhaps there was no branch of science, except that of law, in which Hindus had won more success than that of medicine. When he had the honour of being Vice-Chancellor of the University of Calcutta it was a subject of regret to him that there were so few Hindus who became civil engineers, or devoted themselves to other practical subjects. They turned out admirable advocates and pleaders, and made excellent judges. They were also capital accountants and distinguished in literature, but there were one or two departments in which they did not make that progress which the founders of the University expected. He trusted, however, as time went on, their talents would take a more practical development. They all heard with great regret that this was to be one of Dr. Mouat's last appearances, but he hoped, like the typical manager, they might have one or two more "last nights," and that his long and valuable services, whether as Inspector of Gaols, as Secretary of the Council of Education, or as Poor-law Inspector in this country, would meet with some adequate recognition from the Government he had so long and faithfully served.

Surgeon-Major PRINGLE said it was a real pleasure to come to see and hear one whom he had known for so many years, and who had a history in India even before he knew him, at Juggernauth, in 1885, which was when he was Inspector-General of Prisons. There was an immense deal of work done in the world in a quiet way which could never be repaid nor requited; but after all, the *mens conscia recti* was a very valuable possession, and he could not help thinking, in this connection, of the great man who only wished it to be recorded of him that he tried to do his duty. What more noble record of any human being could there be? In looking back over his thirty years' service in India, he knew of nothing more practically important in the lines of education than the medical branch of the Hindu University. No human being could gauge what that had done. It was simply recorded in the paper that it had taken the place of the Greek, Egyptian, and Hindu art of medicine, but few realised all that that meant. As a sanitary officer travelling over a very large tract of country, he had met these students from the Medical University, and the result of their studies had been to change the whole character of medical and sur-

gical treatment in the country. If they could see poor people coming to be operated on for cataract now, and also see, as he had, the old instruments which were formerly used on such occasions, they would recognise what a change had been effected in one line only. It was the same in other things, and the future only could give even an approximate idea of the blessings which had been in this way conferred on the people. Under the head of medical education, the disappearance of caste was now remarkably illustrated by the levelling of the third-class in railway travelling—for instance, at Saharampur, the station for Hurdwar, where it was surprising to watch the people coming out of the railway carriages, and see how caste had disappeared. He remembered Alighur, in the North Western Provinces, in 1864, when it was a quiet military station. There was there a man of great influence amongst the Mohammadans —Sir Syud Ahmed, then chief civil judicial officer, —with whom he had had many long conversations, and who was then preparing a great scheme of education which he had now been able to carry out, and he was sure Dr. Mouat would be much pleased with that college if he could see it. It was established and supported by the perseverance and zeal of this one man, and what its future would be was very difficult to estimate, because it opened up an entirely fresh country. As one of the results of university education in India, he might mention as a remarkable circumstance that in this jubilee year of the Queen, a young lady, Miss Cornelia Sorabjee, had come to the front and obtained the highest honours at the Bombay University. It was very striking to go to the Observatory at Benares or Delhi, where you could see astronomical instruments constructed on an enormous scale, one of which, at Delhi, was probably the *fac-simile* of the sundial of Ahaz, on which the shadow went backward ten steps, or degrees. When he thought of these observatories, he could not but wonder what the future results of university education in India would be. But whatever might be its future, the name of Dr. Mouat would be inseparably connected with it.

Mr. MARTIN WOOD said he could not pretend to speak on this subject with any completeness, but with reference to Dr. Mouat's apology for his apparent egotism, he might say he wished there was more of that, for it was only from such personal recollections of a state of society which was rapidly changing that one could realise the importance and significance of those changes. It was nearly twenty years since he had the honour of a parting call from Dr. Mouat, in India, and he had listened to his narrative with the very greatest interest. He wished particularly that the Madras and Bombay side of India had been more represented. No doubt the circumstances were very similar, but there were differences which were very interesting. He would not attempt to dispute Dr. Mouat's opinion that Bengal took the leading position in the educational history of India, especially in higher education; there was no doubt it took precedence in point of time, but it might be a question whether some other centres had not shown a little more advance in the breadth of the collegiate instruction afforded. With regard to Dr. Mouat's criticism on Sir Henry Maine's estimate of the progress and effects of university education, there was much justice in the remark that, with all his powers, his utter absence of the knowledge of the vernacular had very much to do with the serious mistakes he had made in that estimate. Allusion had been made to the interesting circumstance of a degree having been conferred on the first lady bachelor in an Indian university, at the last Convocation at Bombay. He had a report of the address of the Vice-Chancellor on that occasion, and it was very interesting to see the way in which he referred to this event. He said, "You will recognise the propriety of my first of all dwelling on the circumstance that this year we have our first lady bachelor. This university was one of the first in her Majesty's dominions to recognise the equal rights of either sex to the honours and distinctions which it confers;" and he added, "I may remark that in those universities which first spread the light of the renascent learning through Europe, learned ladies were never wanting, and if one looks to the history of Padua one recognises the propriety of Shakespeare drawing his advocate from that university." This reminded him (Mr. Wood) of a very important fact in connection with the universities of India; no doubt it applied to Calcutta and Madras, but it did most emphatically to Bombay; and that was the continuous and sometimes signal munificence with which the universities had been supported by free gifts from the community around. In referring to that Vice-Chancellor West said, "We have this year, as in past years, many expressions of the free confidence in this institution of the great community in which we are placed. To them it is, as it ought to be, the pillar of the people's hope, and the centre of this little world's desire. Whenever the resolution exists in the breast of a cultivated member of our community to connect his name with some benefit to his fellow-countrymen, we find now that as a rule he resorts to this university, and we have some blessing, some bounty, to acknowledge in the speeches which are annually delivered from this place. Nor is this year an exception." This showed how deeply rooted was respect and affection for collegiate instruction in the minds of the people of India. Not only those who were themselves literate, but many of those who had not received such advantages, were amongst the most prominent benefactors to education. There was one remark he should like to make as to the influence of collegiate medical education, quite apart from its direct influence in medicine and surgery. That training had given a taste for general scientific knowledge, and

aptitude in applying it, which was of immense value to India in a variety of directions.

The CHAIRMAN, in proposing a vote of thanks to Dr. Mouat, said that he had received several letters regretting the inability of the writers to be present; amongst others, one from the Rev. James Johnson, Secretary to the late National Indian Council of Education. He desired to record his conviction that this paper was one of the most important contributions to the unwritten history of India to which he had ever listened. Though he had some personal knowledge of the matter, there were points in it which to him were entirely new. There were others which had come under his notice during a long connection with Indian education, but which had never been presented so fully and accurately as they had now been set forth. The principal point which Dr. Mouat had brought out was the fact that education in India was the product of a quarter of a century of continuous labour by distinguished Indian servants of the English nation, before the Dispatch of 1854. It was often supposed, but quite inaccurately, that that Dispatch marked the commencement of English education in India, and Dr. Mouat had referred to certain articles of a fugitive character which appeared in the *Times*, entitled, "The India of the Queen." He had read those articles with some attention, but he did not gather that the author ascribed to the Dispatch of 1854 the initiative of Indian education. He gathered his meaning to be that the efforts made prior to that had been lamentably inadequate, and that the Dispatch marked the true commencement of education on a scale commensurate to the enormous work to be done. Dr. Mouat had confirmed in some important respects the popular notion of the importance of the Dispatch. The official conscience before that time, as represented by men like Dr. Mouat, or Mr. Seton-Karr, or the late Sir Cecil Beadon, had long been active, but the practical result, as represented by the action of the Government, was altogether inadequate to the task which had to be performed. There was something touching in Dr. Mouat's narrative of how the Council of Education in Calcutta, and through it Dr. Mouat himself, had urged a scheme of universities for India upon the Government and the Court of Directors, and how the only answer which he and his friends received was a *non possumus*. There was no argument whatever to show that the scheme was premature, that the measure proposed was too expensive, or unsuited to the requirements of the natives at the time; the answer was simply *non possumus*. Dr. Mouat himself, as one of the great labourers in the cause, would bear him out in that statement. The paper also had been most valuable in bringing forward a little-known side of the character of Lord Dalhousie. It was one of the misfortunes of India that the life of that great Governor-General had never been written. He rejoiced to hear that Lord Dalhousie had completely sympathised with the desire of the Council of Education to give a university system to India before the Dispatch of 1854 was ever penned. It would be found, in time to come, that Lord Dalhousie was not only the father of Indian railways and public works, but also of Indian education, and that he, more clearly than any English statesman who ever went to India, foresaw that great consolidated and educated empire which is now known as the India of the Queen. Dr. Mouat had spoken of the birth of the Indian universities, and had mentioned that owing to his absence from India during 18 years, he was unable to bring the story down to date. It had been his (Sir William Hunter's) fortune to be connected with Indian education in several capacities during his quarter of a century's service. He was appointed to take charge of the largest division of Bengal during the famine of 1866, when the schools were disorganised, and the pupils were on the point of flying to their homes in consequence of that great calamity, and he thus saw a good deal of the rural working of the system of education at that time. Among the most useful institutions in the Bengal districts were certain schools which dated long before the Despatch of 1854 — the Hardinge schools, established by the great governor-general to whose services Dr. Mouat had referred. He (Sir William Hunter) had afterwards to revise the whole existing system of education throughout India as President of the Education Commission, and more lately he had the high honour of being one of Mr. Seton-Karr's successors as Vice-Chancellor of the Calcutta University. The story of the beginning of that university was very interesting, but it might receive an additional interest by a brief narrative of the results which those early efforts had produced. The university held its Entrance Examination in 1861, in canvas tents on the Calcutta plain. It was a body corporate without a habitation, and had to camp out to examine its students. Now they had one of the most magnificent buildings in India as the Senate-house of the university, and instead of a few hundred undergraduates, they had between four and five thousand young men annually coming up to pass the Entrance Examination. He thought he was within the mark in saying that the Calcutta University, in point of numbers, now stood first among the universities of the Empire. Such was the result of the scheme which Dr. Mouat, with his own hand, drew up, something like forty yearys ago. Nor were the results those of numbers alone. Sir Joseph Fayrer had borne tribute to the high standard attained by the Calcutta University in medical science. He (Sir William Hunter) had had the opportunity, as an examiner in honours at Oxford, and also as Vice-Chancellor, and a very old Fellow, of the Calcutta University, of comparing the papers —not in medicine, but in arts—which were set by the English and the Indian universities. He did not assert that the standard on the whole was so high in India as in England, but the proficiency exhibited in the subjects actually set was equal. They did

not dare in India to require so much, but they insisted on at least as high a standard of excellence in the subjects prescribed as was required at Oxford and Cambridge. Mr. Seton-Karr was quite correct in saying that in his day few students devoted themselves to civil engineering and similar subjects, but that defect was now being remedied. There was an excellent engineering college in Calcutta, which, as regarded the results attained, might be fairly compared to the great college in arts—the Presidency College—whose origin had been described. It was, naturally much smaller, but it was doing admirable work, and was giving a practical turn to hundreds of young Indian students. Two gentlemen had referred to a lady graduate in Bombay—Miss Sorabjee, whom he had the pleasure of knowing. But, as an old Fellow of the Calcutta University, he must deny to Bombay the credit of passing the first lady graduate in India. In 1877 it was his happiness to confer upon three ladies the degree of Bachelor of Arts, and to one lady the degree of Bachelor with Honours in Sanscrit. A similar distinction had been only once earned by a lady in any British university—viz., in Cambridge. For the first time in the history of a British university, Calcutta gave a degree in honours to a young lady, in January, 1877; and in June of the same year, when he was at Cambridge, a certificate of Honours in Classics was conferred upon a lady. The difference, however, was this, that Calcutta gave an actual degree, while Cambridge only gave a certificate. A great deal had been said about the influence of universities upon social reform, and he believed that they were profoundly affecting the whole mode of native thought with regard to domestic morality and political duty. This was not the place to refer to any question of politics, but he believed that in India, as elsewhere, a nation advanced, not upon any single line in regard to their domestic institutions, or their religious beliefs, or family life, or political aspirations, but upon all lines at the same time, and he believed an onward movement was taking place in India at this moment such as had never been seen since the revival of learning in Europe. They had heard something about the unfitness of natives for representative government. That was a point which he would not touch upon, but there was one aspect of it that very nearly affected Indian universities. The other day he was talking to certain heads of colleges at Oxford, who were complaining that they could do nothing without a committee, in fact that they could do few things without several committees. Now, in India, the governing body of the university was appointed in such a way as enabled the utmost amount of work to be done with the least possible friction. In England, Fellows of colleges were elected by the body of which the college consisted, but in India the Fellows were appointed by the Viceroy, or in the case of a local government by the Governor, and gazetted in the official journal. There was, therefore, in India, almost alone amongst the universities of the empire, a university system, wholly appointed from above, in the constitution of which the most distinguished members of the university took no part. When he was Vice-Chancellor of the Calcutta University he had the pleasure of conferring with the Vice-Chancellor of Bombay upon the subject, and it seemed to both of them, and to many other eminent authorities whom they consulted, that the time had come when, in some degree, the educated youth of the universities, who had completed their education and obtained degrees, should be allowed a voice in the direction of the university. This principle had been adopted by the Government in the Punjab Universities Act. It had also been adopted in the Act for the New University, at Allahabad, in the North-West Provinces. It therefore seemed to him that if the universities of two comparatively backward provinces were permitted to elect a certain proportion of their Fellows, the time had come to consider whether the older and greater universities of Calcutta and Bombay might not receive a similar constitution. The movement in Calcutta was now in other hands, and it would not be proper for him to say anything which might anticipate the decision at which his his successor—the present Chief Justice of Bengal—and his colleagues might arrive. But in Bombay the Vice-Chancellor, Mr. West, had gone on with the scheme, and he believed that a Bill was now before the Legislative Council for enabling certain Fellows—certain members of the governing body—to be elected by the members of the university itself. Whatever might be thought of representative government as regarded the *haute politique* of India, he thought all would agree that this was an admirable opportunity for trying how elective institutions would work among university men themselves. It was not proposed to give any voice to undergraduates. But the M.A.'s, or perhaps the Fellows, or it might be the members of the university assembled in Convocation, would furnish the electoral body. It was desired by the universities themselves, and it was acknowledged by the Government, that the time had come to permit the men whom they had trained up on a university system to take a part in the direction of that system. That was the most recent development of university education in India. The system had been planted by Dr. Mouat and his friends nearly half a century ago. It was now bearing noble fruits, such as would have rejoiced the hearts of the men who were then acting with him as colleagues, men like Mr. Drinkwater Bethune, Sir Cecil Beadon, and others whose eyes were not permitted to see the good results of the seed they had sowed. Dr. Mouat had taken part in one of the noblest efforts which had ever been made by England in India, and when all present had passed away, that great spiritual growth which he had planted and watered would continue to flourish, and continue to produce even greater benefits for the people amongst whom he had so long laboured.

Sir William Hunter concluded by proposing a hearty vote of thanks to Dr. Mouat.

Dr. Mouat, in reply, said he wished from his innermost heart that he deserved in any degree the kind things which had been spoken of him. He could honestly say that he did his best, that he put his whole strength into the work, and was glad to find some of his old colleagues here who recognised that what he did, he did to the best of his ability. He could only say of the Council of Education that, having done so much, why they did not do more was entirely on account of two potent factors, first, want of power, and, next, want of money. Had they had the means and possessed the authority, no doubt they could, with the men working with them, have effected very much of what he was sincerely glad to find had been accomplished since.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 21st, 1888; Colonel Sir Owen Tudor Burne, K.C.S.I., C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Bonner, Horace Thomas, 29 and 30, King-street, Cheapside, E.C.
Cox, John Buchanan, 27, Apach-road, Brixton-rise, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Tucker, John, Talbot-house, Rickmansworth.
Walker, Samuel, 22, Moorgate-street, E.C.
Yeates, A. G., More-hall, 85, Tulse-hill, S.W.

The paper read was—

THE EVILS OF CANAL IRRIGATION IN INDIA, AND THEIR PREVENTION.

By T. H. Thornton, C.S.I., D.C.L.

When a person who is neither engineer nor medical expert, nor practical agriculturist, presumes to read before this Society a paper on canal irrigation in India, he owes some explanation to his audience. My excuse is, that circumstances have led me to take keen interest in the subject, and afforded me special opportunities for studying it from different points of view. During part of my service in India, I was in charge of a district irrigated by the Western Jumna Canal, and thus was eye-witness of some of the evils I describe. Thereafter, for nearly twelve years, I was attached to the Government of the Punjab, in a capacity which enabled me, at different times, to visit every canal-irrigated district in the province, and obtain information from every class of persons interested—from engineers, district officers, medical experts, irrigators, and representatives of the general public.

But whatever may be my *locus standi* in the matter, the facts adduced are, for the most part, from official sources, and the suggestions offered are not my own, but the borrowed light of others, far better qualified to advise than I am.

With these preliminary remarks, let me proceed to deal with the important subject we are considering this evening.

The canal systems of India have been justly described as the finest in the world. Whether in the form of inundation canals, that is, canals fed by the annual rise of the waters of the Indus and its tributaries, or of perennial canals drawn from the upper waters of the Ganges, the Jumna, the Rávi, and the Satlaj, or formed in the deltas of the great rivers in the south, they have conferred priceless benefits on the community. They have secured from drought upwards of eight millions of acres—an extent of country far greater than the whole of Lombardy, or the entire irrigated area of Egypt; have increased enormously the production of superior crops, enriched the people, and set free the capital required for working wells for the improvement of produce and the cultivation of fresh lands. Within my own recollection, they have turned deserts into gardens, softened the climate of extensive tracts, substituting rich cultivation and foliage for treeless plains swept over by sandstorms; while in Southern India, thanks to the persistent efforts of Sir Arthur Cotton and others, they are largely used as highways for internal traffic.

All this is well-known and appreciated; but it is not so well-known that these vast benefits have—in the case of the canals of Northern India certainly, and probably also, to a greater or less extent, in the case of other canals—been accompanied with evils, some of them of a serious character, affecting large tracts of country and multitudes of human beings, and tending, unfortunately—in some localities—to increase rather than diminish.

It is to these evils I propose to draw your attention this evening, not with the view of discrediting canal irrigation, or discouraging its extension under proper conditions, but of offering and inviting suggestions as to the best means of mitigation or prevention, and

pressing upon the authorities of India the necessity—in the interests of human life and health, if not on other considerations—for far more complete and vigorous action in this really urgent matter than appears to have been taken hitherto.

This is not the first time I have ventured to draw attention to these evils. Two years ago, I wrote a brief paper on the subject for the *Journal of the East India Association*, and it was honoured with the criticisms of the distinguished canal engineer, Sir Arthur Cotton. These criticisms will be dealt with later on; here it will suffice to state that they have enabled me to explain, develop, and greatly strengthen the case I have to lay before you.

The evils of canal irrigation to which I refer are:—

First, extensive impoverishment of soil, and deterioration of produce in the case of lands irrigated by canals derived from Himalayan sources, as compared with lands irrigated by wells.

Secondly, waterlogging and swamping of the soil in localities where subsoil water is near the surface.

Thirdly, the bringing up to the surface salts known locally as "*reh*" and "*kallar*," prevalent in some of the clay soils, and thus poisoning the surface soil, and rendering the cultivation of all but a few crops impossible.

Fourthly and chiefly, the extension and intensifying of malaria, to the serious detriment of the health and physique of the population of canal irrigated tracts.

And their existence may be generally traced to one or more of the following causes or conditions:—

First, absence or inadequacy of drainage.

Secondly, over-irrigation by cultivators.

Thirdly, interference with natural surface drainage by canal earthworks and watercourses.

I proceed to give evidence in support of the above statements.

1. *Impoverishment of Soil.*—This evil is peculiar to canals fed from Himalayan sources, and does not follow irrigation from inundation or deltaic canals, the waters of which are warm, and charged with fertilising silt. Its existence, however, even in Himalayan canals, is stoutly denied by Sir Arthur Cotton. Generalising from his experience in South India, where the conditions are different, he says, "the water from wells is filtered, and almost entirely without fertilising properties, while river water is so rich as fully to renew the land. . . . Probably canal water is worth three times that from wells." Again, referring specially to Himalayan water, he says, "the dry season water must be greatly inferior to the monsoon water, but it must as certainly be much superior to well water."

But hear what the present Lieut.-Governor of the Punjab, Mr. J. B. Lyall, an experienced settlement officer, says (Punjab Famine Report, p. 307):—"Without doubt, constant cultivation and application of canal water tend to take the strength out of the land."

Hear the statement of Rajah Sir Sahib Dyál, a considerable landowner in the Punjab (p. 309):—"It is commonly believed in the Amritsar Pergunnah that the canal water has made the soil poor. . . . In the canal-irrigated villages of Gurdáspúr the people say that the canal water has injured their soil."

Hear Muhammad Hayát Khán, an experienced Indian official (p. 311):—"Irrigation from canals leaves a sandy deposit on the surface of the soil, and weakens it."

Hear the statement of Mr. E. C. Palmer, C.E., Superintending Engineer of the Bári Doab Canal, whose bias, if any, would be in favour of canal irrigation. He admits (p. 308) that on stiff clays (and such is the character of the greater part of the soil of the Punjab) "although the use of canal water doubtless ensures an average crop, the same soil, as a rule, will, under well irrigation, yield a heavier and better quality of grain per acre." Again: "After the first three or four years of canal irrigation," he says, "a marked deterioration of produce takes place;" and he adds the following remarkable expression of opinion:—"I am of opinion that to grant canal water where the spring level is less than 25 ft. below the surface, is a waste of water and an injury to the land."

The same evil—deterioration of soil and produce—is referred to as a matter of general complaint by Mr. Sherer, in his Report on the Western Jumna Canal villages, in 1857, and by Captain (now Lieut.-General) Crofton, R.E. in his Report on the Ganges Canal, in 1864. "The crops," he says, "raised by the present canal irrigation are, in general, notoriously inferior to those watered from wells."

Lastly, let me quote the remarks of the distinguished expert, Sir James Caird, made after visiting the localities concerned ("India; the Land and the People," p. 206):—"In those irrigation canals, which are fed from the

melted snows of the Himalyas, the water comes down at a temperature much below that of the land to which it is applied, and carrying with it a deposit which is barren sand. The effect of this pure cold water on vegetation is only permanently useful when the land is sufficiently manured, and becomes positively hurtful when lavishly applied year after year to unmanured land. Irrigation from wells on each man's land is not open to this objection, as the water is used with economy and only on manured land."

Of course the remedy for this deterioration is, less lavish irrigation and more manure. But, unfortunately, manure is not to be had in sufficient quantity, and the extension of canal irrigation, by developing crop cultivation and contracting pasture, and dispensing with well cattle, tends materially to reduce the small stock available.

In view of the facts and opinions given above, and the malarial and other evils which I shall hereafter prove to accompany canal irrigation in low-lying tracts in Northern India, the conclusion seems a fair one that canal irrigation should not, in Upper India, be applied, as a rule, to new tracts of country easily irrigable by wells, or, if applied at all, applied only in aid of well irrigation, not in substitution for it, but reserved for localities where well irrigation is costly or impossible. An exception must be made in the case of regions like Sinde and the west of the Punjab, where the climate is so rainless that even cattle fodder cannot be grown without irrigation. The well irrigator does not, it is true, make such rapid profits as the canal irrigator, but he is well off, has more manure, better produce, more self-reliance, and often a good deal better health. Hereafter, when drainage is more perfect, the system of water distribution improved, and the sanitary condition of the people more assured, the extension of canal irrigation to these tracts may be desirable; but for the present do not destroy flourishing well irrigation, or discourage its extension, for the doubtful benefit of a canal.

2 and 3. *Waterlogging of the Soil, and Reh Efflorescence* occur under similar conditions, viz., over-saturation of land, an undrained subsoil, and water near the surface; but to produce *reh* efflorescence saline matter must be present in the soil also. The *reh*, or *kallar*, consists mainly of a mixture of sulphate and carbonate of soda, with chloride of sodium in various proportions. The *reh* crops out on the surface of the soil affected with it in a white efflorescence, sometimes three or four inches thick. Its first action is to absorb moisture and keep the ground dry. But when water is added in sufficient amount, it dissolves, and the solution, unless greatly diluted, prevents the absorption of liquid by plants, stunts their growth, and eventually kills them. According to Colonel Wace, the present Financial Commissioner of the Punjab (Punjab Famine Report, p. 301), large tracts of land in the Punjab are thus injured, but the evil is most widespread in the lands irrigated by the western Jumna canal, where some 30,000 acres of once fertile soil have passed into swamp, or become defertilised by *reh*. Mr. Ibbetson, the settlement officer of Karnál, gives the following graphic description of the situation:—"The whole country," he says, "is waterlogged by the canal water being forced into it from below, while the cultivator drenches it from above. And when the rain comes in tropical abundance—instead of finding a thirsty soil, ready to drink up the greater part, it falls upon a country already saturated with water, and the whole volume is thrown into shallow drainage lines, with an almost imperceptible slope. These, again, being barred at intervals, by high banks crossing them at right angles, silt up, and the water is thrown back, and covers the country for miles." This is not all, for "the rain, falling upon the soil, has washed down with it more or less of its saline constituents into the spring water below. The water has now been raised within such a short distance of the surface that it can rise to it by capillary attraction, carrying with it the salts which have thus been accumulated; the water evaporating leaves the salt deposited, and this process, repeated year after year, eventually covers the soil with a flocculent layer of salts, lying like fresh fallen snow, often three or four inches thick. The salts lie thick round the edges of cultivation, and are carried over the boundary by rain. When once the cultivation is destroyed, the capillary process begins, and thus the evil is gradually eating its way from the outside into the still fertile fields, every inch gained being a stepping stone to further in-roads."

In the North-West Provinces, Captain Crofton, R.E., reported, in 1864, that the whole irrigated area required thorough drainage, and Lieut.-Gen. Brownlow, R.E., late Inspector-Gen. of Irrigation, informs me that at the present time about 3 per cent. of the irrigated area, or 60,000 acres, are affected

with *reh* efflorescence, involving a loss of rent to the amount of, at least, £60,000 a year.

The remedy is really efficient drainage and copious washing of the soil; and in view of the loss of rent incurred, it would be justifiable, on economic grounds, to spend a million sterling on fhe reclamation and drainage of *reh* tracts in the North-West Provinces alone; and it should be borne in mind that, under the provisions of the Northern India Canal and Drainage Act, a fair portion of the outlay, or the interest on it, would be recoverable by an additional rate on the irrigated lands. It must further be remembered that the present state of things is no fair measure of the evil to be dealt with; for the evil, like a canker, will extend and develop in both Provinces, unless the prime cause of it is removed.

4. *Extension of Malaria.*—The evils I have described above are evils affecting the land and its produce, and the revenues derived therefrom. The fourth evil is one affecting human beings, and is at once more widespread and more desolating in its effects; but it is the result of similar conditions, and requires similar remedies to the two last.

My friend, Mr. Justice Cunningham, in a paper read by him before this Society on the 27th January last, draws attention to the fact that by far the principal cause of death and disease in India is malarial fever, and he adds:—"It is, I fear, impossible to acquit several of the great Indian canals of having, certainly at some, if not all stages of their history, tended to increase the liability of the population to fever and the deadliness of that disease."

Perhaps the most glaring instance of this is to be found in the much vexed tract already mentioned as the chief centre of irrigation swamping and *reh* efflorescence—I mean the lands of the Western Jumna canal. This canal, originally constructed by native rulers, was greatly developed subsequently to the famine of 1833; but neither in its original construction nor in its subsequent development was any regard paid to the drainage of the country irrigated. The natural lines of drainage were dammed up by the canal and its watercourses, the soil became a swamp, and the people fever-stricken. In 1841, 1842, and 1843 the mortality from fever was so terrible that, in 1844, the cantonment of Karnál had to be abandoned. In 1845, a Committee was appointed to investigate the matter, and reported, in 1847, that the unhealthy conditions were due to interference with natural drainage of the country and over-saturation of the soil. Little or nothing was done—the sickness remained, and the *reh* and the swamp became worse. Then Mr. Sherer (the collector of a neighbouring district) was deputed to make a general survey of the canal tract, and, in 1857, submitted his report. In this report Mr. Sherer gives a graphic account of the development of swamp and *reh*, and of the appalling wretchedness of the people of the 60 affected villages. The result of this report was a strong recommendation by the distinguished engineer, Colonel Baird Smith, then Superintendent-General of Irrigation in the North-West Provinces, that the canal should be re-aligned, and a carefully matured system of general drainage carried out. Little or nothing was done for eight years; at length, in 1865, a definite project for the remodelling of the canal was submitted by Colonel Crofton, and was the subject of official correspondence between the Punjab Government, the Government of India, and the Secretary of State, which lasted many years. Meanwhile, in 1867, the Punjab Government appointed Dr. Adam Taylor to make a sanitary survey of the tract. He reported marked improvement in certain localities, the result of better drainage, but found many villages in which from sixty to eighty per cent. of the residents were suffering from spleen disease, and drew a sad picture of the general languor and lassitude, and stunted and shrivelled form of the inhabitants of the canal-irrigated area. Writing in the same year, General Richard Strachey—now member of the Indian Council, then Inspector-General of Irrigation for India—used the following words:—"It is impossible for me to affirm, with too great positiveness, the moral obligation which rests on our Government to put an end, with all possible speed, to the discreditable condition of the large tracts of land along the Western Jumna Canal." Ten years elapsed, and Mr. Ibbetson, an officer engaged in the re-settlement of the Karnál district, again reported on the condition of its canal villages. After describing the development of *reh* in the words I have already quoted, he continues, "The saline water, and such rank grass as is able to spring up in the salt impregnated land, give the cattle diarrhœa and glandular affections, enfeeble, and eventually kill them; while the large area, which is each year covered with water in the rainy season, and dried up by the sun during the remainder of the year, exhales

from its putrefying vegetation a malaria which poisons the blood of the villagers, renders them impotent, and kills them with spleen disease."

Since this was written, I am glad to say, the re-alignment of the canal, urgently recommended by Colonel Baird Smith thirty years ago, and definitely projected by Colonel Crofton twenty-three years ago, has been taken in hand, and a system of surface drainage is being carried out. But surface drainage, though valuable and important, merely provides an outlet for surface water, and is no remedy for excess subsoil water resulting from constant irrigation added to the natural rainfall. It has been calculated that the water used for irrigation from the Western Jumna Canal gives an addition to the natural rainfall of the area irrigated of about 74 inches per annum. What wonder, in these circumstances, that spring levels should rise, and lands become swamped and waterlogged! The proper remedy is subsoil drainage—but subsoil drainage has not yet been attempted. Meanwhile, judging from the sanitary reports, the condition of the people is still very deplorable. In the districts of Dehli and Karnál the fever mortality is almost always in excess, sometimes largely in excess, of the average fever mortality of the province. In 1885, the fever death-rate in the Delhi villages was no less than 42½ per 1,000, and in the Karnal villages, 35 per 1,000. In the town of Sunpat, near the Delhi branch of the Western Jumna Canal, a town of 13,077 inhabitants, there were 833 deaths, giving the enormous fever death-rate of 62·93 per 1,000.

Similar, though less serious, results are observable in villages of the Gurdaspur district, irrigated by the Bári Doab Canal, while the salubrity of Amritsar, Lahore, and the surrounding villages, has been seriously affected; and the evil will steadily increase, unless the cause is effectually removed.

These evils do not result, to any appreciable extent, from irrigation by wells, and only in a minor degree from inundation canals. For in the former case irrigation goes hand-in-hand with drainage of the subsoil, while the fact that each drop of water used means additional labour to man and beast is a potent check on over-watering; and in the latter the climate is so rainless, and the water consequently so precious, that economy is insisted on by all.

In the North-West Provinces and Oude, judging from the Reports of the Sanitary Commissioners, the increase of malaria in canal irrigated tracts has long been the cause of anxiety. In 1885, 80 per cent. of the year's mortality was registered under fevers, which caused 1,124,150 deaths, being 50,053 in excess of the preceding year, and falling at the high rate of 25·48 per 1,000 persons. Almost the whole of the increase occurred in 12 irrigated districts. During the year a special inquiry was made by Dr. Sweeny, Deputy Sanitary Commissioner, in regard to the connection between rainfall, canal irrigation, and fever, when he found that the causes influencing fever arose from the increased moisture of the subsoil, due partly to canal irrigation, but chiefly to the arrest of rainfall drainage, owing to the construction in recent years of a network of earthworks, for the realisation of irrigation channels, roads, and railways. Regarding the Doab, or tract of country between the Jumna and the Ganges, the Sanitary Commissioner thus writes:—"A more fertile or thoroughly utilised land it would be hard to find; but the people are not blessed with health. Go where you will, men may be seen, young or in the prime of life, sad of face, slow of step . . . with spleen enlargement filling all the front of the abdomen." Again, as an illustration of the results of irrigation without drainage, the case of the town of Shámli is quoted from the official record, not of a medical officer, but of an executive engineer of the Eastern Jumna Canal:—"When there was no canal, when the country was dry and parched all round, when higher fields were kept green by water drawn up in bags from a depth of 30, and sometimes 50 feet, then Shamli was a pleasant city in a green valley . . . . . (it suffered occasionally from fever) . . . . . but now that water is plentiful everywhere; and the ground is sodden, the green valley has become a noisome fever-bed, and the town is but a crumbling ruin." He further describes the people as sterile and dying out.

Lastly, in the discussion which followed Mr. Justice Cunningham's paper, Dr. Pringle, late a member of the Sanitary Department in India, observed that "the Sanitary Commissioners were to blame for a vast amount of mortality in the North-West Provinces, by permitting a system of irrigation which was really inundation. It was the worst soil in the country for irrigation, owing to the nature of the subsoil, which held the water underground."

Large sums of money have been spent, of late years, in surface draining the irrigated areas of the North-Western Provinces; but

the surface drainage is evidently far from complete. And it must be remembered that surface drainage provides no outlet for excess subsoil water. Subsoil drainage was recommended by Captain Crofton, in 1864, but no subsoil drainage has been attempted yet.

Similar facts are reported from Bengal. In Shahâbad the level of the subsoil water is stated to have risen throughout the tract irrigated by the Soane Canal, and the canal embankments are said to cause much obstruction to the drainage of the country. In 1885 there was not a single village in the district in which malarial fever was not present, and at Sasseram all the inmates of every house are reported to have been affected.

In the Bombay Presidency, the land near the large cantonment of Ghorpuri has become so sodden with irrigation, that sugar-cane will not grow, while the barracks have become notoriously unhealthy.

In the Madras Presidency the reported death-rate from fever is singularly low, and the canal-areas are said to be perfectly drained. So much so, that Sir A. Cotton assures us "that he lived the best part of his life in paddy fields, and never had an attack of fever, nor knew an engineer being so attacked in the irrigated tracts, nor ever saw a native population so affected." These statements, if they accurately represent the situation, are eminently satisfactory, for the facts, if well established, go to prove that canal irrigation is not necessarily fever producing; but the Sanitary Report is silent on the subject, and fuller inquiry and information seem called for.

The facts adduced above suggest, I submit, the following practical conclusions :—

1. That the drainage of the existing canal irrigated areas of Northern India should be far more thorough than at present, and much more vigorously taken in hand.

We have seen that the drainage of the Jumna Canal area has been talked about for the last forty years, and is not completed yet; while that of the Eastern Jumna and Ganges Canals is clearly insufficient; and other canal areas are probably in a similar condition; yet the reclamation of defertilised soil, and increase of revenue therefrom, which would result from the drainage works, not to mention higher considerations, would justify the expenditure of a large sum, part of which, as I have pointed out, would be recoverable from the persons benefited.

2. That in all new projects efficient surface drainage should proceed, *pari passu*, with canal extension, and form an integral part of the works, and that subsoil drainage should follow promptly, on the state of the subsoil water calling for it.

Sir Arthur Cotton somewhat resents this statement as a reflection upon engineering. A good canal, he properly maintains, includes a system of thorough drainage. "When I speak of a boiler," he says, "I suppose it has a safety valve." It will be seen, however, from the foregoing history, that in the case of the canals of Northern India, the drainage of the irrigated areas was not sufficient when the canals were made, and is not sufficient now. Let us hope, with Sir Arthur Cotton, that in all new projects the mistakes of existing canals will be avoided, but I must confess to some misgivings. The engineers will have the best intentions, but, unless sanitary considerations are constantly and firmly pressed, the paying portions of the canal will probably be pushed on, and drainage estimates cut down, or the works abandoned or delayed for want of funds, while a net-work of small embankments will gradually be developed, seriously impeding the natural drainage of the country.

3. That until the drainage of canal-irrigated areas has been effected, very decided measures must be taken—at any rate in fever-stricken tracts and places where the spring level is dangerously near the surface—to prevent over-watering.

One would have supposed that the good sense and self-interest of the cultivators would have been sufficient to prevent this evil, for the irrigators should know by this time that over-watering deteriorates both soil and health. But it is not so, and there is excuse for them in the fact that the evil is gradual in its effect, and is more or less obscured by its operating conjointly with other potent causes, such as excessive rainfall or impeded surface drainage. Moreover, in the dry regions of Upper India, the thirst of the agriculturist for water for his fields has become as the thirst of northern nations for strong drink; and if water is available with little trouble and without stint, it is used recklessly. Supposing that, in a moment of democratic fervour, the English Government were to become purveyors of beer to the people, supplying it at an enormously reduced price, not at so much a pint or quart, but at so much a "drink," each "drink" being limited only by the absorbing power of the drinker, and the discretion of an underpaid tapster, the result would be that, despite the warnings of temperance, the British la-

bourer would soon suffer from "over-saturation." *Mutatis mutandis*, this is precisely what is going on in respect to canal irrigation in North India.

At present, the water from the Government canals is supplied usually by "flow," that is, it is allowed to run directly from the distributary on to the field by force of gravitation. It is not charged for by strict measurement, but each crop has so many "waterings" given by a very subordinate official, and the only check on unnecessary flooding, is occasional inspection by a few superior officers. This is a system very comfortable for the irrigators, and for the subordinate official, but it is the chief cause of all the over-irrigation from which the country is suffering so seriously.

What is the remedy for this state of things? One remedy, suggested years ago, is to supply and charge for all water for irrigation, by strict measurement, just as gas is supplied to households. This would be an excellent arrangement, but, unfortunately, it has hitherto been found impracticable. Many ingenious water-meters have been invented and tried, but, without exception, they have failed. Would it not be well for the Government, in a matter of such supreme importance, to offer a handsome reward for the invention of a water-meter which will fulfil the requisite conditions of efficiency, simplicity, and cheapness? In Lombardy, I believe, water is sold for irrigation by measurement. Why should not that which is possible in Lombardy be possible in India?

Another remedy, suggested, I think, by Lieut.-General Crofton, R.E. (one of the most distinguished authorities on canal construction and management), when Superintendent-General of Irrigation in the Punjab, was to limit the quantity of water supplied to low-lying villages, leaving the village commune to distribute the reduced amount. Such a plan, it was urged, besides reducing the possibility of over-saturation, would, by making water precious, create a wholesome public feeling in favour of economy. But the idea was rejected at head-quarters as interfering with the revenue; on the contrary, the Calcutta bureau, laudably anxious for the financial success of canals, and unconscious of sanitary evils, proposed, at one time, to exact a water-rate, not only from lands actually irrigated, but from all lands within irrigable distance of the canal, and thus to stimulate the over-cropping and over-watering it is so important to discourage.

Another measure, suggested and strongly urged by the late Sir Donald MacLeod, was that local governments should be empowered, on the advice of their Sanitary Commissioners, and after due notice, to prohibit "flow" or "high level" irrigation in malarious tracts, and require the canal authority to deliver water for irrigation a little below the surface of the field. The cost and labour involved in raising the water even a single foot would, it was believed, suffice to prevent flooding. This suggestion was opposed by the canal officers, as involving too great a sacrifice of revenue, the rates for "lift" irrigation, as it is termed, being only half the rates for "flow," and by landowners and cultivators for obvious reasons. As usual, vested interests prevailed, and the general community suffered.

If none of these suggestions are practicable, let others be proposed; but some palliative remedies ought, surely, to be applied quickly, even at some sacrifice of funds, for, if I am not greatly misinformed, matters must be getting worse and worse, the malaria more widespread, the health of the people more undermined, and the land more waterlogged and defertilised.

Two other proposals suggest themselves.

One, that in view of the increase of malaria, and the constant vigilance necessary to prevent the development of insanitary conditions, such as over-irrigation, rising of spring-levels, or impeded drainage, there should be attached to each canal a representative of the Sanitary Department, whose duty it should be to advise the canal authority in sanitary matters, and give prompt notice of matters or proceedings connected with the irrigation likely to be prejudicial to the public health.

The other, that, with a view to secure greater promptness in design and execution, and more responsiveness to local requirements, the Canal Department of India should be more *decentralised* than it is at present. None but those who have experienced it can fully realise the paralysis resulting when purely local matters are supervised and controlled by a Central State Department located, perhaps, a thousand miles away. Surely, if the interest on canal loans is charged against the province benefited, there can be no need for the minute supervision exercised by the Supreme Government over canal projects and administration, a supervision which—however well intended—has resulted in times past, and will probably

result in future, in constant alteration and revision of plans and estimates, interminable correspondence and inordinate delay.

In conclusion, let me again assure those present that the remarks and suggestions I have presumed to make this evening are made in no spirit of hostility to canal-extension, of the vast importance of which all who know India must be fully sensible, but, on the contrary, with the view of removing objections to such extension by the prevention or mitigation of the evils with which canal-irrigation in North India has been hitherto unfortunately accompanied. It is true that the measures which have been suggested, or others having a like object, may enhance the cost, and reduce perhaps for a time the profits of canals, and probably raise a not unnatural outcry from canal projectors, canal officials, and cultivators; but if carried out they will, if I mistake not, be ultimately beneficial to all parties, economise water, improve produce, and save a multitude of lives.

DISCUSSION.

Mr. J. F. HEWITT remarked that the canals referred to by Sir Arthur Cotton were in Madras, where the nature of the subsoil was very different to that in the North-West. In Madras it was formed from metamorphic and volcanic rocks, whereas in the North-West it was of sedimentary origin, which gave a much more clayey soil, in which water was more likely to lie. He thought the appointment of sanitary officers to every district of a canal would be very valuable, as it would show where the canals were affecting the health of the people, and so enable vigorous remedies to be applied. He also agreed strongly with the proposal to decentralise the management of the canals. Every district officer in India suffered by having his project snubbed by the central Government, which, no doubt, acted for the general benefit, but it was apt to overlook local considerations. There was no doubt of the damage done to the soil from over-cropping and over-watering, and of the necessity for a larger use of manure. To continue taking largely increased crops from the soil without putting anything back must lead to exhaustion. A good deal of the manure in India was used for fuel, but he would remark that in the Punjab, in Behar, and the southern parts of the North-West Provinces, where there was a population averaging six or seven hundred to the square mile—in some districts a thousand—every acre of land was cultivated, including a large portion which could not be cultivated before the Soane Canal was made, but there was little or no manure. What he had proposed for years was that coal should be used for fuel instead of manure. There were large coal-fields within easy distance of Behar; the line from Benares to the most northerly coal-field had been surveyed, and could be constructed for a little under two millions, and the whole of Behar and the southern part of the North-West Provinces, and a considerable portion of Oude, could be supplied with coal at a cheap rate. Coal was already used to a considerable extent in the neighbourhood of Calcutta, and the other day he had a letter from a friend of his in Behar, an engineer, who said the natives there were gradually beginning to use coal. If the cultivators would not use it, the urban and city population would, and it ought to be much cheaper than firewood. Four or five years ago, in the neighbourhood of Gina, the price of wood was about 18 rupees a ton, whereas coal could be supplied at a good profit for 6 or 7 rupees. When it once got to the town, it would soon extend to the country, and manure would be saved, and irrigation, instead of being a danger, would prove a great and permanent benefit.

Major BROADFOOT, R.E., said that Mr. Thornton's suggestions were entitled to be received with the greatest respect, particularly as he was not opposed to canals or their makers. He thought the evils he had enumerated might be reduced to two, viz., those caused by the depreciation of the productive properties of the soil, and those caused by the degeneration of the inhabitants. No one denied the existence of these evils, but they were more marked in the case of the old canals of native construction, such as the Western Jumna. The *pax Britannica* which existed in Hindustan was no doubt a great good, but there were serious evils attached to it. The people were apt to trust too much to State direction, to become less self-reliant. With regard to the canals, it seemed to him that engineers started on an erroneous course. It would seem that the less nature was thwarted the better; but with regard to canals, the engineer stopped the natural flow of water in the valleys and took his channels on the ridge, and so he supposed it must be; but nature was certain to revenge herself. He did not think these evils could be prevented, but he thought they might be minimised, and he believed the Government were prepared to sacrifice the revenue to improve the existing state of affairs. The chief remedy was the scientific alignment of the main distributing channels and restriction in supply, and for this the canal officers should be responsible. Restriction in supply would be most difficult to carry out, and to be successful, all the tact of the officers, backed up by the strength of the Government, would be required.

Brigade-Surgeon A. SCRIVEN said he had plenty of opportunity, during a long residence in the Punjaub,

to notice the evil effects on the health of the people in districts where there was too much irrigation. There was a great waste of water where it was not wanted, and the consequence was there was not enough where it was required. The evil could only be remedied by some system of supplying water by measure, and it was a good suggestion to offer a premium for the best water meter. The pocket of the ryot would then regulate the supply. Another serious point was the want of manure, but on that he was not prepared to speak so fully, but there was a good deal of manure wasted. Some system was required by which the vast drainage of cities and villages could be put upon the land. That was a problem not yet solved, but the very worst possible method of disposing of it was to throw it into the rivers. Since he had been in England he had seen the A B C system in use at Aylesbury, which he was informed was very successful, and he thought it could be utilised in India, where alum was very cheap, and could be carried into effect at a comparatively small expenditure.

Sir Joseph Fayrer, K.C.S.I., F.R.S., said he had never heard a more interesting and practical paper, and though he was not competent to deal with the engineering aspects of it, he might say a few words from the sanitary point of view. He was astonished to find that while the knowledge of the causes of so much of the mortality in India was general, so little was done to obviate it. They had heard in the plainest language what was one of the great causes of Indian mortality; they knew that the group of diseases included under the term fever was much more fatal than cholera, small-pox, or any other epidemic: for one who died of cholera, twelve or fifteen died of fever. What was this due to? All these fevers of an intermittent and agueish character arose from moisture in the soil, and decomposing organic matter. He was glad to find that Mr. Thornton had not said a word against irrigation; it was good centuries gone by, and it was equally good now; and by its means 6,000,000 or 7,000,000 acres of land were fertilised, and it had saved an enormous number of lives, though, unfortunately, it had destroyed some. There were great districts in India in which there was practically no rainfall, and the canals took life to those districts; but they might have too much water, and it was its imperfect application which did the mischief. It was not allowed to drain off, but remained stagnant, giving off unwholesome exhalations, and that caused disease; and until these great interfluvial districts were better managed, the evil would remain the same. There had been many doubts expressed whether the mortality was really due to this cause, but when the fact was realised something would be done, and the water would do its natural work of fertilisation without being allowed to cause death as it now did. It could hardly be that the authorities were unaware of it, for during the last 16 years the Army Sanitary Commission had hardly issued a report without pointing out the necessity of subsoil drainage, and of not allowing the people to live on ground saturated with decaying organic moisture. It was not the water alone that did the harm; if it passed through the soil it was not so pernicious. It was when it stagnated on or near the surface that it was inevitably followed by fever. It was the irrigation water not properly distributed which brought up the sulphates of sodium and formed the *reh* on the surface, and disengaged that unknown quantity which was called malaria, and which produced the big spleens that had been described and other disorders. He trusted the latter part of the paper would be very forcibly brought under the notice of the authorities, for so surely as its recommendations were carried out, so surely would the health of the people improve, and the true advantages of irrigation would thus be obtained unalloyed by those great evils which now accompanied it. Quite recently a large district in Lower Bengal—Burdwan—where there was no irrigation, was visited by fever, but the same conditions were found to prevail; from some cause the natural drainage was defective, and the soil was waterlogged. If great irrigation districts suffered it was not from any peculiarity in the water, but the mode in which it was distributed, and the remedy was to pay more attention to it. How this was to be managed was a problem for engineers, but he did not believe that such men as had designed these magnificent works would be unable to solve the difficulty.

General Maclagan, R.E., said the subject had been dealt with in a most practical and useful manner, but it was one attended with a great deal of difficulty. There were those in India who actually expressed their belief that the existence of canals at all was an evil, but Mr. Thornton had given no sanction to that idea. In comparing canal irrigation with well irrigation, it must be remembered that there were very varying conditions in different parts of the country, and the value of the opinions quoted on this point must depend on the conditions under which they were given. At one time the water of the canals was considered to be the cause of the *reh* efflorescence, but at Karnál, where it appeared very abundantly, the water of the canal had been repeatedly analysed, and found to contain none of the elements which proved so troublesome. On the other hand, the soil did contain those elements; the efflorescence came most abundantly where the water was supplied from a high level, and forced its way up through the soil. At Lahore there were a number of ravines which were generally dry, but after a heavy shower of rain, when the ground was drying up, this white efflorescence appeared on the surface; it was dissolved by the rain as it fell, and appeared in small white crystals afterwards. Colonel Sleeman, in his book on Oude, written long before it was a British possession, mentioned the *reh* appearing where the fields were irrigated from wells, and he said the remedy applied

was to flood the ground abundantly until the water carried the *reh* back into the ground, and left on the surface a sufficient depth of pure soil to receive another crop. Colonel Baird Smith also mentioned *reh* in the neighbourhood of Delhi, which was got rid of in a somewhat similar manner, the ground there being on a slope, by washing it down by large floods of water. At Karnál there were these three great evils, the *reh*, the sterilisation of the soil, and a great amount of sickness. It must be remembered that in dealing with these evils a great deal of money was required, and though the local authorities might be perfectly sensible of them the difficulty in finding the means to remove them was always very great, and, therefore, one could not be surprised at the delay in taking measures which all agreed were very important. On the Jumna Canal, which was the first public work on which he was engaged, these evils were known, and an endeavour made to apply a partial remedy, for at that time the great scheme for a realignment had not been brought forward. The canal was defective, being 500 years old, and having been constructed originally in a faulty manner, but the water was admitted in order that the benefits of irrigation might be conferred on the people as soon as possible. One of his first duties was to survey a portion of the canal which produced excessive swamping, and was held to be the cause of fever, but here came in another difficulty. The very origin of this fever was obscure. The day on which he left the station, close on three-fourths of the 3rd Dragoons were in the hospital with fever, due, it was believed, to excessive water on the surface; but the remarkable thing was, that years before, this canal land had been in a far worse state, and in 1876, Karnál was the healthiest station in Upper India for European troops. For many years, like other stations, it had a turn of unhealthiness, and then an entire change took place. There were numbers of these obscurities to be met with, but he was sure the attention now drawn to the subject would lead to good results.

Mr. Martin Wood said he had feared at first that the paper would tend more than Mr. Thornton intended to discourage irrigation in India, but after the discussion he was somewhat reassured. The question was what proportion of canal irrigation was chargeable to these evils, and they must not allow the impression to prevail that they were necessary, or irrigation would be denounced altogether, which would be a very great calamity; and he believed it would be admitted generally that the storage and conservancy of water in India required all the encouragement it could receive. There were two general sets of remedies, one a thorough one and the other a palliative. The thorough remedy had been already quoted from Sir Arthur Cotton, the highest authority on the subject, who said that if the soil were waterlogged the remedy was to drain it. In the way of palliatives he thought the planting of trees would be of benefit, and wondered that the Forest Department had not done more in that direction. About 1870 there was a correspondence in the Indian papers in which attention was drawn to the qualities of needle-leaved trees, and their power of absorbing moisture from the soil, and if these trees were planted the additional advantage of helping to supply fuel, which was much required, would be obtained. His great anxiety, however, was that the application of water in India should not be discouraged. Immense masses of water were annually carried to sea and wasted, instead of fertilising the land. The chief of the Bombay Forest Department had calculated that in the area of about 1,500 square miles which fed Bombay harbour, over which there was an average rainfall of 100 inches, enough fell to fill a reservoir one mile square and two and a-half miles high; that all went into the sea, filling up the harbour with silt from the hills, whereas if it were saved and utilised, it would be of incalculable benefit.

Mr. L. F. Vernon Harcourt thought the well water must contain as much salts as the water from the canal, because it all passed through the soil, and therefore the chief advantage of well irrigation must be that it was used in smaller quantity. Canal water could only be used for inundations where it was loaded with silt, as in Egypt, where the fertilisation of the land was due to the material brought down by the river; but even there, there were difficulties in the use of low-lying lands, where a kind of efflorescence sometimes appeared, and the only way to remedy the evil was by dosing the soil with water at certain seasons. The real evil was over-irrigation, and insufficient drainage. He saw no insuperable difficulty in the way of measuring the water, but the evil might be greatly met by more efficient drainage.

Surgeon-General Bellew feared the various suggestions made for overcoming the evil would take a long time to carry out, and it was very disheartening to think what would happen in the meantime. It might be worth considering whether something could not be done to instruct people how to adapt themselves to the new conditions in which they were placed by the use of irrigation. When he first went to the Punjab it was a very dry and healthy country, but latterly he heard complaints of the climate on every side. Formerly the people could sit out of doors, and even sleep in the open air, and they enjoyed good health; there was occasional sickness, but within the last ten or fifteen years it had been observed on all hands that sickness had been increasing owing to the greater amount of moisture in the air produced by surface irrigation. The suggestion to use coal was an admirable one, and firewood should be more easily procurable than it was at present. For four or five years before he left India he constantly heard complaints of the difficulty in getting wood

even for cooking purposes, and if it were used for warmth, it would keep the air drier and prevent much sickness. He thought it would be a good thing if a code of rules were drawn up by the Sanitary Commission, showing the people how to adapt themselves to the altered conditions in which they lived. The evil was two-fold, for not only was there more sickness and a lowered physique, so that military officers found a difficulty in recruiting, but the people were largely taking to drink and the use of opium, in the hope of warding off fever, which led to a further deterioration.

Sir JULAND DANVERS, K.C.S.I., said he could not help thinking, while listening to the paper, of the proverbial thorn which accompanied every rose. Efforts were constantly made by men of science to ameliorate the condition of mankind, but there was always something on the contrary side. Even the sanitary arrangements of modern times were sometimes the means of introducing noxious gases and typhoid fever to places which had been free from them before. So it was was irrigation. The Government of India had spent large sums, and employed the most talented men, for the purpose of distributing the water which was so much wanted, and yet there were these defects. In the Punjaub alone something like £6,000,000 had been expended, and 2,000,000 acres had been irrigated, and yet, in some places, ill effects had been produced. The public and the Government were much indebted to anyone who came forward like Mr. Thornton to call attention to a matter of this kind, and he was glad to find that he did not oppose irrigation. The causes of the evil had been well explained, but as General Maclagan had shown, the great difficulty was the want of money. Experiments were continually being made, and the result of those already made had been to bear out very strongly the view that subsoil drainage was required. In one place where it had been tried the fever mortality had been reduced from 55 to 7 or 8 per 1,000, and it seemed to be established that the drainage should be taken at least 6 feet below the surface, for if a less depth were adopted sickness still prevailed.

The CHAIRMAN said he was glad that attention had been drawn to Mr. Thornton's praise of irrigation works, and he was sure everyone would agree that a Government who had spent £25,000,000 in watering tracts which would otherwise have been desolated by famine, and the engineers who had conducted the operations, were entitled to the highest praise which could be given them. They would all agree with Mr. Thornton as to the remedies he had sggested, but the great difficulty with India was its vastness. The Ganges Canal was something like 2,000 miles long in its two branches, with 4,000 miles of tributaries, and the Western Jumna was 600 miles, with 2,000 miles of tributaries; and those were the difficulties which engineers had to meet. At the same time, if any one in this country were going to irrigate a field, the first thing he would do would be to provide drainage before bringing the water on to it, and, commonly, irrigation and drainage went together; there must be a circulation of the water underneath the soil, or the vegetation was destroyed and disease introduced. He concluded by moving a hearty vote of thanks to Mr. Thornton.

Mr. THORNTON thanked the gentlemen who had spoken for the valuable suggestions they had made. That of Dr. Bellew, as to the instruction of the people in the necessity for changes of clothing, and so forth, in reference to the enormous change of climate, which was gradually being produced in the dry regions of the Punjab, he heartily agreed with. When an irrigation canal brought into a country water equal to 74 inches of rainfall, it could easily be understood that a vast change must be going on, and a special effort should be made to instruct the people how to meet it. The suggestion as to the planting of trees was also very valuable, and he might mention that in the report made by Dr. Adam Taylor regarding the canal villages on the Western Jumna Canal, he observed that whereas in village after village he found an enormous number of cases of spleen disease, he suddenly came from time to time on one in which there was hardly any; and on seeking for the cause of this immunity, he found in every case that these healthy villages had a belt of trees round them.

Miscellaneous.

PARIS EXHIBITION, 1889.

A meeting was held at the Mansion-house, under the presidency of the Lord Mayor, on Thursday, the 16th inst., at which a statement was submitted as to the formation of the British Section of the Paris Universal Exhibition.

As a large number of British manufacturers desire to take part in the Exhibition, and as the French Government are naturally anxious that England should be represented, it seems desirable to form some organisation of a responsible, if not of an official character, which might organise the British Section.

In response to an urgent appeal from the Director-General of the Exhibition, the Lord Mayor, with the tacit consent of the Government, undertook to form a committee for the purpose. The immediate result of the first invitations issued by his Lordship was of the most satisfactory character, and it has proved no difficult task to get together a strong and thoroughly representative committee. From this committee an

executive council has been appointed, and great care has been taken to include representatives, not only of various branches of industry, but also of the chief manufacturing centres of the country.

The amount of space which will be placed at the disposal of Great Britain and the Colonies will be about 14,000 square metres (150,000 square feet). This, though less than half the amount occupied by this country at the Paris Exhibition of 1878, is yet amply sufficient for a large and satisfactory representation of British industry. It is not inclusive of the space available for the fine arts, arrangements for which will be made later.

The most important question for the committee, in the first instance, is that of finance. They have not, as in 1878, the resources of the Treasury to rely upon. On that occasion a sum of £67,000 in all was voted, and this enabled the work to be carried out on a more liberal scale than can be hoped for on the present occasion. It is evident that all the necessary funds must be provided either by the exhibitors or by those who are ready to subscribe in order to ensure that their country shall take its proper place at a foreign Exhibition. It is hoped that a certain amount of assistance may at all events be looked for from this latter source.

The main cost, however, must fall upon the exhibitors themselves, and the only fair way of dividing this cost amongst them will be by making a charge in proportion to the space occupied by each exhibitor, a charge, that is to say, of so much per square foot. The precise amount of this charge it is very difficult to decide; all that can be said at present is that it is certain the charge for space cannot be less than 5s. per square foot, while it ought not greatly to exceed that amount.

But whatever estimate is made, it will be necessary to provide a sufficient margin for unforeseen expenditure and miscalculation, even though the utmost care may be used to avoid them. A guarantee fund is therefore absolutely necessary. Is is hoped that no call whatever may be made upon this fund, but, to protect the executive, such a fund is necessary. The guarantors will have every reason for feeling that in giving their assistance to the Section, they will do so without much risk of their being put to any expense. The Lord Mayor and the committee are greatly indebted to those who have already generously contributed to the donation and guarantee funds, before any public appeal has been made.

Lord Brassey moved:—"That this meeting pledges itself to promote the interest of the Paris Exhibition, and to use its best endeavours to secure an adequate representation of British manufacturers."

The resolution was seconded by Sir Bernhard Samuelson, M.P., and carried unanimously.

The Lord Mayor, in acknowledging a vote of thanks, stated that he had taken such a prominent position in the movement with the tacit consent of the Government, who had promised every help.

Correspondence.

AGRICULTURAL BOOK-KEEPING.

In the paper on "Agricultural Education," 14th inst., farm book-keeping is certainly not ignored, but some of your country members regret that greater prominence is not given to the subject. As the practice of Würtemberg is quoted (p. 472), let me state that itinerant teachers were there employed, throughout the rural districts, to teach one uniform system of making up accounts; that even females were instructed in it, and that its principles and practice were made applicable to most other branches of industry.

We are told (p. 465) "that an educated man is a free man and not a drudge, nor yet possessed with a soul-absorbing concentration on his bread-study;" but many of us believe, rightly or wrongly, that the science of agriculture must be pursued as a "bread and butter" science. Our chief reliance at present is on thrift. We think that greater economy in production is desirable, yet we feel that there is small chance for the introduction and permanent adoption of any new theory or process until a profit can be shown upon it. The test of gain, clearly proved, we regard as the soundest and simplest argument. It would avoid much waste of words and funds. For such test, a recognised standard of keeping accounts is an agricultural necessity; the method must be easily understood and widely enforced, *e.g.*, in our Law Courts. Believe me, we should welcome an extension or diffusion of the study of the science of finance in agriculture quite as much as that of any other. Without it, neither "the roseate view" taken by the Professor, nor "the deplorable state" described by one who followed in the discussion, can be admitted as "proven." JOHN YEATS.

Chepstow, 19th March.

SCIENCE AND ART DEPARTMENT.

Professor Silvanus P. Thompson, in his letter in your last issue, says that my letter of the 5th March requires to be supplemented by a not unimportant fact to which I make no reference, namely, that he had a personal interview with one of my own official staff on the very point on which, according to me "the Department had no reason to suppose," &c. I was quite aware of the interview, for the careful official who took part in it noted it at the time on the papers. The date was the 25th September, 1875. But if anyone will take the trouble to refer to my letter, he will see that when I stated that "the Department had no reason to suppose that he desired to specialise in organic chemistry," I referred to Professor Thompson's application to be admitted to the school, on which his selection to attend the

course on biology was based. This application was received on the 19th May, 1875.

As in the correspondence which took place after his selection for a studentship in training, Professor Thompson, by quoting an official letter with a full stop and a comma transposed, converted a negation into an affirmation, so now, by ruthlessly knocking my sentence about, he makes it appear that I said "that the number of studentships being fixed 'by the capacity of the school,' those in chemistry were full." What I did say was that "the studentships in training in chemistry were full, the numbers being fixed by the capacity of the school, and the need of teachers in various branches of science," a somewhat different statement, the worth of which is in no way invalidated by Dr. Thompson's remark that he entered the department of chemistry as a fee-paying student.

The difference between exhibitions or scholarships and studentships in training is well known, and, I presume, was recognised by Professor Thompson in 1875, for he entered himself for "studentship in training." However, the only point in relation thereto of interest to the public is that which I endeavoured to make clear in reply to Professor Thompson's statement "that the Science and Art Department's notion was to get men who could teach everything," viz., that a "scholar" has to go through one of the several *curricula* required for the associateship of the school, while "a teacher in trainiag may, if he desire it, confine himself to the study of one subject, and the rule is to restrict him to one group of allied subjects."

J. F. D. Donnelly.

20th March, 1888.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

April 11.—"Recent Legislature concerning the Pollution of Air or Water." By Alfred E. Fletcher, Chief Inspector of Alkali, &c., Works. Professor Sir Henry E. Roscoe, M.P., F.R.S., will preside.

April 18.—"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S.

Foreign and Colonial Section.

Tuesday evenings, at 8 o'clock :—

March 27.—"The Panama Canal." By J. Stephen Jeans.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

April 24.—"Craftsman and Manufacturer." By Lewis Foreman Day.

May 8.—"The Decorative use of Colour." By J. D. Crace. E. C. Robins, F.S.A., will preside.

May 29.—"Persian Textiles." By Cecil Smith.

Indian Section.

Friday evenings, at Eight o'clock :—

April 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. Robertson, M.R.A.C., Principal, College of Agriculture, Madras. Sir James Caird, K.C.B., will preside.

May 4.—"Caste." By Dr. G. W. Leitner.

The above dates are liable to alteration.

Cantor Lectures.

The Fourth Course is on "Alloys." By Professor Chandler Roberts-Austen, F.R.S. Three Lectures.

Lecture III.—March 26.—Colours of metals and of alloys considered in relation to their application to art, with illustrations mainly taken from Oriental art metal-work.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys." (Lecture III.)
Teachers' Guild, Memorial-hall, Farringdon-street, E.C., 8 p.m. Mr. W. H. Widgery, "Language."
Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. C. M. Woodford, "A Naturalist's Explorations in the Solomon Islands."
Actuaries, The Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. J. Stephen Jeans, "The Panama Canal."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Further discussion on Mr. P. W. Willans's paper, "Economy-Trials of a Non-Condensing Steam-Engine—Simple, Compound, and Triple." 2. Mr. Arthur Ayres, "Compressed Oil-Gas, and its Applications."
Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, March 28...Geological, Burlington-house, W., 8 p.m. 1. Mr. Valentine Ball, "Some Eroded Agate Pebbles from the Soudan." 2. Mr. Valentine Ball, "The Probable Mode of Transport of the Fragments of Granite and other Rocks which are found imbedded in the Carboniferous Limestone of the neighbourhood of Dublin." 3. Messrs. J. Starkie Gardner and Henry Keeping, "The Upper Eocene, comprising the Barton and Upper Bagshot Formations." With an Appendix by Mr. H. W. Monckton.
Chemical, Burlington-house, 8 p.m. Anniversary Meeting. President's Address. Election of Office-Bearers.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. Ambrose A. Myall, "The Development of Machinery in relation to Hand Labour."

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FRIDAY, MARCH 30, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor Chandler Roberts-Austen, F.R.S., delivered the third and last lecture of the course on "Alloys," on Monday evening, 26th inst., in which he treated of the colours of metals and of alloys in relation to their application to art.

The Chairman (Mr. W. Matthey, F.R.S.) proposed a vote of thanks to the lecturer, which was carried unanimously.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 20, 1888; Professor T. Hayter Lewis in the chair.

The paper read was—

WHAT STYLE OF ARCHITECTURE SHOULD WE FOLLOW?

By William Simpson, R.I., Hon. Assoc. R.I.B.A.

". . . . the goddess, who bears on her head a single ostrich feather, being Justice or Truth. In the sculptures of Thebes we find Pthah not only accompanied by her, but bearing the title, 'Lord of Truth,' in his hieroglyphic legend; and Iamblichus, who calls 'the Artisan Intellect the Lord of Truth,' observes, 'that whereas he makes all things in a perfect manner, not deceptively, but artificially, together with Truth, he is called Pthah,' though the Greeks denominate him Hephæstus." —The Ancient Egyptians, by Sir G. Wilkinson.

Often in conversation on the architecture of the day, I have been asked the question which forms the title of this paper. It is rather difficult to give an off-hand answer, because the subject requires the definition of some principles which are necessary for its proper understanding. It shall be my purpose here to explain the ideas essential to its consideration, and although I cannot say in this paper all that such a subject as this would require, yet I shall try to give a few suggestions which appear to me as indicating the proper course to be followed. The question has a wider bearing than its application to architecture; it is intimately related to the whole subject of applied art. Whatever may be the principles we lay down to ourselves for the beautifying of stone or marble, or other building material, will apply more or less to the ornamentation of metal, wood, leather, pottery, or textile fabrics of any kind. If we assume this to be the case, the subject will take a direct bearing on the whole question of decorative art.

An architectural friend, on hearing that I had undertaken this paper, asked what line I intended to follow. After I had explained, he said, "Ah, we all know that; you will have the public with you, and all the architects against you." Well, my own conclusion was that these words were encouraging; it will be something to have the public with me, but I should also like to have the architects as well. I feel in my own mind that they must give up the line they have been on, and sooner or later that they will have to follow another path. When my friend used the word "we," if he meant that all the architects knew or understood the ideas indicated, I must express my dissent. That my friend is acquainted with the views I hold on the subject I have not the slightest doubt, for he stands high as an authority on architectural matters, and, as what I am about to lay before you is not new, it may be presumed that many architects are familiar with the ideas I have adopted; but judging from the buildings we see erected around us, as well as from designs which are exhibited when competitions take place, I should say that the great body of architects have their minds in a chaotic condition of confusion as to the principles of their art. I do not limit this criticism to the lesser luminaries of the profession, for we can point to the celebrated failures in erecting great public buildings where leading architects have been employed. Practical architects are generally very busy men, they have in their work so much to do with materials, construction, and many other details, that little time is allowed them for the study of abstract prin-

ciples, or the relation of their art to æsthetics. In truth, an architect has so much to learn in what I would call the scientific part of his education, that he might never find out whether he had, or had not, any sense of the beautiful; which I should suppose, looking as I do on architecture as one of the fine arts, was the first essential among the natural endowments that an architect ought to possess. I am often struck with examples of our ordinary street architecture, at seeing some houses which are ungainly and vulgar in every line, while others, however simple the effort may be, indicate the true artist with the power of giving beauty to whatever he touches. I have from this often thought it would be a great advantage to architecture if the two distinct branches of it—the scientific and the æsthetic — could be separated, and each branch given to men with the natural qualifications for them. I suppose that in the present condition of the profession this is out of the question; but it would be a great point to gain in the future if a division of labour in this way could be carried out.

It is the exercise of the æsthetic faculty which entitles architecture to rank as a fine art; without this it would be mere building, and nothing more than a mechanical occupation. It is the manifestation of this faculty in structural design which raises architecture to the same high dignity as painting, sculpture, music, and poetry. This is a noble position to occupy; but exalted position implies necessary conditions. Now, what I have to submit is, that architecture in our own times has not realised these necessary conditions, and that this explains why it has so failed in its aims. This may be fairly well illustrated by showing how different our canon of criticism has been in art and literature, when compared with its application to architecture. There was a time when men wrote imitations of Horace, and were accepted as poets, but that is a thing of the past. In our own day, if an author aspires to the laurels of the Muses, if the critics can substantiate the charge that he only echoes the ideas and words of others, his failure is complete. To be a plagiarist in verse is to be less than nothing. In art the canon is almost as strict. The man who only copies old masters in the galleries, and sells them, does not rank as an artist; and any individual who copies the subjects and the style of painting of another is judged accordingly. Contrast this with our architects. For the last three centuries they have done nothing but copy. Men have earned fame and distinction whose work has only been the copying, more or less badly, of the architecture of the Greeks. There has been no secret in this; it has been done openly; and men have gloried in the doing of it. That which would have been denounced among artists, and stigmatised in literature, as plagiarism, is honoured among architects.

Here, it seems to me, is the condition which architecture has overlooked, and which is essential to any art, if it desires to maintain its position among its sister arts. We have only to compare results when the value of these very different canons of art become manifest. About a century ago, poets began to discontinue the imitations of Horace, and ceased to take the poets of Greece and Rome for their models, and we have only to look back over the period since this change took place to see what a bright array of names have appeared, many of them names that will never die. There may not be any of them who have risen to the very highest rank in poetry, but it must be remembered that there are many centuries between the birth of a Homer and a Shakespeare, and we need not be surprised if one century has not produced an equal to either of these great reputations. Painting was a little later in throwing off the classic trammels, and freeing itself from the old masters, but it did this at last. It was when painters went to nature instead of to the galleries of Italy that art sprang into a new life in this country. We all know what has resulted from this. Our national faith does not demand pictures in its worship—hence this highest walk of art has been neglected; but in every other branch the success of our artists has been to the utmost degree brilliant. A few names may be mentioned to recall what has been done. Wilkie left the Dutch painters far behind him; Landseer stands on a proud pre-eminence which no animal painter before him had reached; Stanfield eclipsed all previous sea painters; Canaletto was the great painter of architecture, but David Roberts, known as the "modern Canaletto," has done far finer work; and Turner reached a pinnacle of fame to which nothing in the past can be compared. I give these few names of men who are passed away, which would be sufficient in themselves for my purpose, but I might add largely to them, and not exhaust the list of modern artists of high repute. The Manchester Exhibition, last year, was the place to see and judge of what has been done in painting during the Victorian era.

What has architecture achieved during the same period? Its only fame is written in failure. It is not necessary here to give a list of important public buildings, which are a standing evidence of what is affirmed. Not only in the metropolis but all over the country these monuments of failure are staring us in the face; not a structure has been erected to which we can look to with satisfaction. Our architects have not succeeded in developing a style that we can call national, or describe as being expressive in any way of the period in which we live. The dismal result is so patent and recognised, that complaints are heard on all sides, accompanied with inquiries as to how this state of things is to be remedied, and it is when such laments are being made that we hear the question asked, "What style of architecture should we follow?"

In this I have given only the briefest suggestion of what has been accomplished by architecture, painting, and literature; the full comparison might, in itself, fill a paper of this kind; and it is so important in its bearing on the whole question, that I would ask all to think the subject out more fully for themselves. Most people are acquainted with the past of literature, and many are familiar with the transformation which art underwent; but I fancy that many are not so conversant with the history of architecture during the same period; on this account I shall give a slight sketch of it, and then you will be better able to form a judgment. I have often found that questions which were at times doubtful on their own merits at the moment become easy enough in their solution when their previous history, and the events which led to them, were studied; and I think that our present subject receives considerable light from its past position.

About three or four centuries ago there took place in Europe a great and sweeping change in all things pertaining to learning, which is now known as the Renaissance. This movement had a marked effect on literature, painting, sculpture, and architecture. The literature, the art, and the architecture of Greece and Rome became the models for nearly the whole of Europe. I have already referred to the emancipation of literature and painting from this influence. In the case of sculpture we have another lesson. It could not shake off the bonds so readily as painting, and it is even yet partly under the old traditions, and the consequence is that we have no sculpture of any consequence to point to with pride. Our public monuments, as a rule, are a laughing-stock. That change in architecture took place with what we call the Gothic revival. Roughly speaking, this began about the beginning of the century, and led to what is well known as the "Battle of the Styles," that was between the advocates of the Gothic and those who adhered to the classic models. The "Battle," I suppose, is now over—from other changes which have taken place, I hear nothing more upon this subject. I think it continued for something like half a century; and now I wish you to take a brief survey of what took place—let us look over the battle-field. If I might venture to give an opinion, it would be that the Gothic men had rather the best of the struggle. Their numbers slowly increased, and towards the end they seemed to be the majority. I know that at last very few buildings were put up with pediments or Corinthian capitals—if I may take these as outward and visible signs of the work of the Classic men. Although there was for a time success thus far, the Gothic revival is now looked upon as a failure. There are Gothic men, and good ones too, still at work firm in their faith; the new style, known by most people as that of Queen Anne, has eclipsed it; there are other styles as well which seem to be rising into favour. In London here scarcely a Gothic building can be seen going up now. Think what this means—it is, that half a century at least has been lost by our architects in a barren struggle. That is a very serious matter. It is rather sad to think that such a large body of educated men were engaged for fifty years or more discussing what kind of architecture we should adopt, and that neither of them properly understood the problem they were attempting to solve. The explanation of this may be what I have already hinted at, that architects are so much taken up with the scientific branches of their profession that they have not given the artistic branch its due share of consideration. This may or may not have been the case, but we have to consider why the Gothic revival turned out a failure. To me the reason is not far to seek—the Gothic men only copied. There may have been exceptions to this, but as a rule they only repeated the forms of the older Gothic. It might be said that it was only a "renaissance," exactly as the Classic revival had been. This, at least to me, sufficiently explains the failure.

The Queen Anne style is now in full bloom. Some object to it being called by that name

because it contains features which do not strictly belong to the period of that queen's reign. To meet this objection, a compromise has been suggested, that it be called "Queen Anne's Grandmother's style." For the sake of shortness I shall, without pretence to perfect accuracy, use the first name of the style. I can scarcely pretend to speak seriously of this last architectural revival. The old Battle of the Styles had at least some dignity about it; there was valuable research and knowledge of the past on both sides; the two styles for which each side fought were among the most highly developed kinds of architecture the world had produced. Each could appeal to some of the most noble and perfect buildings that exist. Nothing of the kind can be said for the Queen Anne style. No great structure was ever produced in it; it is perhaps the lowest type of architecture which grew out of the Renaissance. Those who are familiar with the beauty of Greek mouldings must be shocked to see the coarse, vulgar imitations of them which our Queen Anne men go on repeating. The Battle of the Styles was entitled to be considered as something respectable, but this new style is only a farce after the serious piece. It may be that I have not carefully enough studied this last departure; but so far as I have paid attention to the buildings—of which specimens are plentiful enough—there does not appear to be anything in them but repetitions of forms which previously existed. So far as I understand it, there is no pretence of anything beyond copying. It is only another Renaissance, and its fate is not difficult to foretell.

I often wonder when our architects will discover that this copying is hopeless. They have gone from one style to another, and yet there has been nothing but failure. Will they go blindly on from style to style as before? There are plenty of other styles to imitate. The means of travelling in our own day has enabled artists and photographers to visit all parts, and now we have material at our feet from which almost every architecture in the world might be produced. Must all these styles have their day; must our architects hop from one to the other, as they have done, from Classic to Gothic, and from Gothic to Queen Anne, before the error is found out? I hope not.

After what has been said, I need scarcely tell you that the answer to the question which heads this paper will be that no style of architecture should be followed. This requires a qualification which will be given. A style of architecture may be followed, if it is done with the intention of developing new forms from it; or, if that which had been formerly done in the style is understood as not being the ultimate limit to be reached. The Classic revivalist, if he had a Doric building to design, had only the idea that his highest aim was to produce something as perfect as the Parthenon; for him there was nothing beyond. The Gothic revivalist most likely desired only to reproduce as perfectly as he could the peculiar character of 13th century, or some other period of mediæval architecture which he had selected to work in. To realise this, and nothing more, was his ideal. Each of these men had finality before them; whilst the true faith of the artist must be that there is no finality in art.

This copying is, I believe, the principal point on which I shall have the architects against me. They say that all architecture, from the earliest times, has been copying. If this is the crucial test of our question, it may be well to go into it a little more fully. It is perfectly true that architecture, as practised in the past, was carried on by copying. A style of architecture, or a school of art, means that a number of people are working on the same lines. The phrase is almost equally true if applied to art or poetry. The gift of originality is rare; and all who are without that power remain only copyists in the school to which they belong. Read poetry, and you will find that most of it is only the echo of what others have expressed. Go to our exhibitions and you will see how many of our artists are like sheep treading on well-beaten paths. If any man makes a success, either with a new class of subject, or a new method of treatment, he is honoured with scores of imitators. This is perfectly true, but I must ask you to remember the qualification which I have just given. Our painters are free from the fetters of the idea that any particular style or manner is the ultimatum of art. They are open to the idea that new methods are possible, and that it is open to every man to be original if he has the capacity which will enable him to attain to that distinction. This implies a mighty difference in the matter of copying. We have the results before us. In painting new men do appear; new schools have grown up, aye, and schools that will be celebrated in time to come. The school of British landscape will be looked back upon with respect in all future times. While that school was progressing to such eminence, our architects had the blank wall of finality before

them, they were shut in, and they never got beyond it. I would say that it is this possibility of progress, or rising to higher things, which existed in the one case, and existed not on the other, which has made all the difference. At least we can point out that the one has produced results; while the other has given us nothing.

Let me take one bit of detail to illustrate this still further. I do so, because I think that the reference to this detail may be applied to other details, and that it might thus be spread over the whole question. Has anyone ever counted the number of Corinthian capitals on our buildings in the metropolis? There are hundreds, if not thousands of them. I must again remind you—although it belongs to the A B C of principles—that copying is not, in a sense, art. It is not the man who carves the statue but him who made the model that we call the artist, unless it should chance that the "sculptor's ghost" is a cleverer man than the master—which at times is the case. According to this simple canon, which I have never heard doubted, these hundreds, or thousands, as the case may be, of Corinthian capitals do not represent the slightest effort of art, for they are all more or less copies of Corinthian capitals from Greece or Rome. It will be seen now that the subject of this paper relates to the "applied arts." It includes the whole range of design—that is, artistic design. Here the very words speak for themselves; design is design—not copying. It seems to me incredible—and I would fain doubt it if I could—that such an educated and intelligent body of men as architects must be at all times, could have continued for so many years ignoring the first and simplest of art rules. Doubt is impossible in this case, for the Corinthian capitals exist yet as evidence. I have given this as one piece of detail; you have only to follow this up with the other details. There are Ionic and Doric capitals; there are columns and their bases; architraves and mouldings; there are ornaments such as the "egg and dart," the honeysuckle, &c. In all these the Classic revivalist merely copied, designing he never thought of. There may have been those who thought of developing a new architecture from the Classic, if there were, they made but small progress, and their work is without fame. The men of this body who rose to repute were those who reproduced most faithfully the character and details of the architecture of Greece and Rome.

Here I may take the opportunity of saying that I am not seeking to depreciate Classic architecture. In my travels I have seen fine architecture in many lands, and I may not be quite so absorbed in my admiration of Greek as some are. I may say the same of Gothic; it is not their merits I am dealing with. It matters not in the present case how perfect they may be; I am only objecting to them, or to any other architecture, when they become side lines on which art may be shunted, and thrown off the main line of true principles. Neither have I said anything against the study of Classic or Gothic; the architect should know all styles; from each he might learn something; and he would understand his own all the better from a knowledge of the others. I often smile when I remember what my master first told me when I began architecture. That was nearly half a century ago—he began my instruction by telling me that there were five Orders, and, as if recollecting himself, he added, "and there is the Gothic;" it had been very nearly overlooked by him. That style did not stand high in his estimation, for he added that it was doubtful if it should be looked upon as architecture. I think we have all advanced in our knowledge since my friend taught. We have now the finest specimens of architecture from the four quarters of the globe, which includes a goodly number of styles that my early master never lived to hear of, and with all these before us it is difficult to be as exclusive in our ideas as he was.

I must return again to the subject of copying, for it is the main point to be dealt with. All artists have to begin their career by copying pictures; by this means they learn from what others have done before them. The young artist, from his natural bent, selects some school or master which he chooses to follow. Here is copying, but legitimate copying, for its object is the education of the artist. Wilkie copied the Dutch painters, but his theory of copying did not prevent him from attempting to improve upon his masters. Turner copied Vandevelde and Claude; he painted in each of their styles till he excelled them. He copied many styles, but his true fame came when he ceased copying and became "Turner." All great artists have copied largely. Copying might be called the foundation of art, but not its end. One school of art, by copying, grew out of another shool of art, and according to the originality of the men of the new school so was its fame. This recalls

to the mind that to assert that all architecture in the past was copying, although mainly true, is still not quite accurate. Architecture did change; it was slow to do so no doubt, but still mutations took place. Altered conditions produced in time new forms, and new styles arose. The birth and growth of new styles is evidence in itself that copying was not an absolute dictator in the past. In the Eastern Empire the Classic architecture changed to the Byzantine, and the Byzantine again was transposed into what I shall call the Saracenic, as that is a well-known word. In the west, the architecture of Rome became the Romanesque, and the Romanesque must have found innovators when it was transformed into Norman. Some architect or school of architects must have ceased copying the round arch when the pointed one took its place. Here was the birth of the true Gothic. The Gothic did not remain stationary; it underwent many changes before it ceased with the appearance of the Renaissance. Even in India, where *dustoor*, or "custom," is paramount, and where permanence of type might be expected, if that were possible, changes took place in architecture, and many of them of a very marked character. From this it will be seen that architecture in former times has not been limited altogether to copying. Changes took place, in fact they were constantly going on; changes at times for the worse, at times for the better, and in many instances—as remains at the present day show—new and very beautiful styles came into existence. Had there been nothing but the practice of literal imitation of existing forms, these transmutations would have been impossible.

I think I have said enough now about copying, and I hope I have made it clear enough. The whole subject can be summed up in one sentence,—he who follows must always be behind.

I have given an answer so far to the question which forms the title to this paper; but it is only a negative one. It is rather difficult in matters of this kind to say what should be done. You must remember that new schools of art, or literature, are developments or growths. No single individual can produce such a result. It requires a number of persons to be all working on the same lines, and it also requires time; and no one can predict what would be the result. As the first part of my answer has been of a negative character; any suggestions I have to make will be of a similar kind.

Let us suppose a number of architects agreeing to work out a new school of architecture. What should be their first object? Should they all meet, with their drawing-boards and T-squares, and begin to evolve the new architecture? They might try this, but they would not succeed. In the first place, they would not be able to agree; but the more important objection to this method is, that the end could not be reached by this means. It is only by practical working that a new architecture is possible. It cannot be evolved out of the inner consciousness of one man or any number of men. A structure should be adapted to the purpose it is intended for. This brings before us the question of utility in architecture, a question which should never have existed. It grew up from imitating styles of the past, which were evolved out of conditions entirely different from those of the present. If an architect produced a design, a particular style was understood; a house was designed in that style, and if there were any shortcomings as to convenience or fitness, complaints were useless; you had selected such a style, and there it was. The comfort or wants of those for whom the building was intended was quite a secondary consideration. Supposing a gentleman with a large estate had, in the early part of this century, gone to a Classic architect to build him a new house; to a certainty, the end of a temple—that is, a pediment and so many columns supporting it, would have been the main feature of the principal front; this might have been flanked with wings, partaking in their appearance something of the character of a barracks or a workhouse; and most probably there would be a row of sepulchral urns along the top. Behind this strangely constructed front the necessary accommodation would be laid out. A few years later, the gentleman might have found a Gothic man, and, if he was a superior one of the kind, the probability is that the house would be designed from the peculiarities of the ecclesiastical style of the mediæval period. The rooms might be like chapels or mortuary vaults, and the windows might not be adapted for letting in light or air where the latter was wanted; but to make up for all this you had the correct Gothic of the period agreed upon, done, perhaps, by the best man of the day for that sort of thing. The Houses of Parliament are a good illustration; Tudor Gothic was the style selected; but Members of Parliament do not seem to be contented with Tudor Gothic alone, however perfect, after they have got

it. I cannot pretend to enumerate the many other things not peculiar to Tudor Gothic which they have asked for, including a room in which they may be heard when they rise to speak. Mr. Street, as you are aware, was considered about the best Gothic man we had, and we may take it for granted that the Law Courts are good Gothic of the kind; but the men of the law are as far behind as the Members of Parliament in their want of appreciation of style, for they have grumbled about the deficient accommodation and other most unæsthetic points of detail ever since the Law Courts have been opened. Utility should be the first object with an architect. It is the *raison d'être* of a building, and no other consideration should be allowed to interfere with this primary consideration. It is the faithful fulfilment of every purpose for which a structure is erected, the meeting of every new requirement which may grow up, that produces new forms, and this is one of the principal experiences which by its action should lead to legitimate development. If I have stated the case here correctly, it will be seen that time and experience, in order to meet all these requirements are essential conditions in the evolution of an architectural style. From this it may be deduced that a synod of architects, however able they might be, could not invent one.

Assuming this to be the case, it points to the conclusion that some style should be taken from which to start from. All previous styles have been developments from pre-existing ones. Such has been the condition in the past, and by accepting this we would not be ignoring the experience of what has taken place.

At first thought it may naturally appear that the style to be selected would be a matter of importance. The choosing in this case should certainly not be done without due reflection. Still, if it is clearly understood that whatever may be the one adopted, it is only as a basis; it is to be merely the ground on which to build upon, and ought to disappear in the process; almost any style would do; it might possibly be an advantage to start from more than one style. It might lead to more variety as an ultimate result, which would be a good quality to have, for there is nothing more melancholy than monotonous uniformity in our streets. I have in my recollection new streets that were made in the centre of important towns, and where the town council had determined they would have something architectural as an ornament to the place, and had the buildings all designed in a uniform style before building began in them. I know more than one of these efforts; but the result in them all can only be described as something dreary and almost sepulchral.

I think that trabeate architecture is not suited for this country. That style began with columns to support an entablature, and was adapted to a warmer climate than ours; we require solid walls. The main objection to it is that brick is our principal building material. The arch is natural to the brick, but not the lintel. I am aware that something like a lintel, I think it is called a "flat arch," can be produced with bricks; but then it is bad building. The best way to verify this is to take a ride through our streets on the knife-board of an omnibus, which brings the eye more on a level with the upper windows of the houses, and it is rather surprising to see in how many cases the walls have given way in connection with these flat arches. In this we have a very effective lesson which bears on the copying a style of architecture where the material used in the copy is different from that which has been imitated. These flat-arches are said to have been made after the model of the lintel, when Classic architecture was the only style recognised in this country. This may seem a trivial matter, but there underlies it the whole question of good building. Large stones for lintels can be procured, but they have, in most cases, to be brought from a distance, and they are expensive; at best they are not so strong as the arch; an arch built with stone would be better than a lintel. Good building, that is using the material, whatever it may be, in the best manner for attaining strength and consequent durability, should never be overlooked in architecture.

As a style to begin with, the Gothic might answer the purpose very well. It gives us the arch in more than one form. We have the round Norman, the pointed, and the depressed arch of the Tudor period. As it would be understood that Gothic was only to be a starting point, the narrow windows and consequent darkness which is associated with this style would be given up at once. Here we have an instance of following forms in architecture without considering under what conditions they came into existence, and whether those conditions had continued. In the Middle Ages glass was rather a scarce article, and only made in small pieces; on this account windows were made narrow; in our day panes of glass can be made to almost any size, and

the necessity for small or narrow windows has passed away. In the so-called Queen Anne style I see that small squares of glass are one of its features; after what has been already said, such Simian imitativeness requires no comment.

Here I must say something in favour of the Gothic men and of what they did. It may be presumed now that the Gothic revival has been a failure; still the "Battle of the Styles" did a great deal of real good. When the Gothic revival began, a pointed arch was quite sufficient to satisfy those who began the movement. That produced what was afterwards known as "Carpenter's Gothic;" by and bye, as the style began to be studied, a better appreciation took place, and ultimately the spirit of Gothic was caught up by the better men, and churches, as well as other buildings, were produced with a wonderful faithfulness to the old models. This implied careful study and knowledge, and while this was going on, some of the minds engaged discovered that the Gothic of the past was not all perfect. Some of it was good, and some was far from being so. It was also discovered that forms which had served a purpose were continued after the necessity for them had disappeared. This led to an eclecticism, and a general criticism of the architecture, as it had been formerly practised. A few of the architects—only a few—began to reject all useless forms, all redundancies and excrescences; this they carried out in their designs, producing something like an approach to good architecture. I believe that some of these men had begun to look upon Gothic as the starting-point of the architecture of the future. Some of them reached ideas so close to those expressed in this paper, that I make no claim of originality to anything that is here given. I have heard it all before, only it seems to me that it has been forgotten, or ignored, and on that account I think it may serve a good purpose to reiterate what has long seemed to me to be the true principle to be followed.

We have many improvements which are due to the Gothic men; they advocated good building, and it is to them we owe the disuse of "compo," or the cement with which it was the practice to cover so many houses. If walls are to be hid under plaster, or any composition of that kind, good building is hopeless. "Compo" was the "jerry builder's" delight. That is all a thing of the past, and now we have "honest brick," as it was called in contradistinction to the compo. This itself has made almost a revolution in our street architecture. I forget now whether it was the architects of the Gothic, or if it was John Ruskin (I rather think it was the latter), who first advocated what was looked upon as a dreadful heresy—that common deal would be better, and even more beautiful, to be simply varnished, instead of being smeared with paint to make it look like oak or some other kind of wood. It should be noticed here that the guiding rule is that there should be no shams, no falsehood, a rule as essential to good architecture as to good morals. Let it be remembered that Pthah, who was the deification of the builder in the Egyptian mythology, had the title of the "Lord of Truth," a very high authority for this view of the subject.

I rather think it was the very palpable shams existing in the classic school of the time which first led the Gothic men in this direction. In the "Battle of the Styles" this became a strong point of attack, but at the same time it caused them to investigate the Gothic more minutely, to see what was true or false in it. Had all the Gothic men wrought the subject out to its full bearings, and kept the principle before them in practice, I feel sure that we would have had by this time a developed Gothic—that is, an architecture rejecting all shams or falsehoods, and adapting itself thoroughly to the requirements of the time. The mass of the Gothic architects, I fear, did not quite realise the necessary principle, and here we may find the reason why the Gothic has been a failure.

Gothic is not yet quite extinct, and I noticed a good illustration of shams the other day. There are some Gothic buildings which have lately been put up near the Temple Station. I have no idea who the architect is that designed them. On the upper part there are some bold and picturesque gargoyles—they are rather a striking feature of the architecture, for they project well out into space—so much so that if the rain water of the roof is to be led off by them, it will rather astonish the passers-by on the pavement. If the gargoyles are not mere dummies, they will certainly be a matter for the police.

It is going over old well-beaten ground to point out one or two of the shams of the classic school as it was and is still practised. Many who hear this paper may not be familiar with the "Battle of the Styles," and this principle of truthfulness is so essential that it is necessary to understand

how architecture has been practised in the past, so that we may be able to arrive at the right road leading to a style which will give us truth in construction. The motto of the Architectural Association is "Design with Beauty. Build in Truth." These words come now like an echo from the battle-field of the styles, and they show how far some of the Gothic men had got on the right way; but these words will tell you that I am only repeating what has already been expressed. The last three words, "Build in Truth," are of such primary value that a paper like this might be exclusively devoted to it; and I can only pretend here to give you one or two examples by way of illustration.

I have already mentioned the pediment which was derived from Greek architecture. It was originally a constructive form, and was the end or gable of a Greek temple; from the arrangement of the temple, the approach to it was from one of the ends, which on this account became the front, and the pediment became a prominent feature of the style. As the sloping lines of the pediment represented the angle of the Greek roof, it was at first perfectly true as a constructive form. Supposing one of our Classic men had a building to design with an extensive frontage, we would naturally imagine that he would have placed a pediment at each end of the roof. In the first place the pitch of our roofs is too high to have suited the Greek or even the Roman pediment; but this has but little to do with the motives of the Classic architect. The pediment had formed part of the front of the Greek temple; and whether there was, or was not, a roof terminating in the front, a pediment must be placed there. The style demanded it, and truth in building had never been thought of when this style was exclusively practised. I only ask you when going about our streets to look at the frequency of these pediments on our buildings, and also to note that they have nothing whatever to do with the roofs. You will also notice them over the cornice of doors and windows; you will find them, too, inside of our buildings, as well as on furniture, showing that the original intention of this form had been entirely overlooked, and that they are all architectural shams.

The pediment surmounts the entablature, and the whole had pillars in the Greek style to support it. Our Classic architects had also their pillars to support the pediment; but it is evident that if the thing to be supported was useless, the supporters were equally unnecessary—it was only the adding of one sham to another. There are some buildings without the pediment, but they have a Greek entablature, with columns, half-columns, or perhaps pilasters to support it. This is not so palpably preposterous as the pediment; still this sort of design is equally unreal; the columns pretend to support that which is either unnecessary or does not require support. Mr. Statham, in his Cantor lectures,* delivered before this Society, gives a very good instance of what he calls "falsity in architecture," and he points to the Colosseum at Rome as a fair example. The Romans added the arch to their style, but they continued the Greek forms with it. In the Colosseum, as well as in many other buildings, the arch is the real support of the architrave, but the architrave implied the column, so that member is added; and, as a support, it pretends to do what is accomplished by the arch. In this case the arch is a reality, and the column a structural fiction. It will be readily understood how this mode of attack and manner of dealing with architectural forms was relished by the classic men. The column, the entablature, and the pediment comprised their whole working material; and to say that their use was pretence or imposture in modern times, was practically to deprive them of their whole stock in trade. They had nothing else to work with.

The Classic men had to find a justification of their practice, and their reply was that all previous styles of architecture were copied from styles which had been practised before. This was perfectly true. The Roman copied from the Greek, and the Greek style was only a repetition of a previous wooden form of structure. We can trace a similar process in the Egyptian; in India we can trace how forms have been copied and re-copied for two thousand years back. In China ancient remains of architecture are not common, but still indications of this practice are to be met with also in that country.

I think I have here given, simply but still fairly, the main question on which the "Battle of the Styles" was fought. The above is the turning point on which each will decide as to which party he will follow. If anyone thinks that copying may be practised in architecture, he will have no difficulty in taking the side of the Classic men. If, on the contrary, he considers that originality is a necessary requisite in architecture, as in art, he must reject every style

* Cantor Lectures on "The Elements of Architectural Design," by H. H. Statham, p. 21.

which is based on the repetition of forms belonging to the past, and which have no reference to our present requirements. For myself, I began architecture in the Classic school, but as soon as I understood the question there seemed to be no difficulty on its merits, and I have seen no reason since to alter my judgment. Even the revival of the Queen Anne style has failed to convert me, and our architects may, when that fashion has worn out, go on to others. They may try Saracenic or Egyptian; they may even go as far as India, where they will find a multitude of styles to imitate; and beyond that, again, there is China and Japan. All such revivals, I believe, can only end in failure.

This paper is a short one, dealing with a large subject. I have only been able briefly to indicate ideas, which would require great space to work out, in order to do proper justice to each part of the question. I will now say a few words on the justification given for copying by the Classic men, because this is connected with what I am about to suggest before coming to a close. It has been pointed out in a former part of this paper, that though architecture as practised in the past consisted of copying, still we have to remember that changes took place. Time acted slowly enough perhaps, but new wants and conditions did arise; these had their effect at last, and we know that architecture did undergo mutations, and that new styles came into existence. This is equally as true as the statement about copying. Now what produced the new styles? New wants and new conditions led to new forms, *and they ceased to copy the old.* I emphasise these last words. There is the process in the past under which a new style came into existence, and I submit that this process must be gone through again if we are to produce anything new and original in architecture which will be suited to the present day.

We have no reason to suppose that the architects of the past knew any other manner of architecture but their own; or at least all such knowledge must have been very limited. As a rule they inherited the style they practised. They most probably did not know how their own particular style had originated, and under these circumstances they could not submit their architecture to any form of analysis. We live now in an entirely different period. Nearly all the architecture of the past has been collected and is before us; a great amount of it has been investigated, and the origin of its forms explained. This places us in a changed position from the men of the past. The question of truth in architecture could not have arisen with them. This mode of looking at the subject in relation to falsity or truthfulness has resulted from our knowledge, and if we transgress, the excuse of ignorance cannot now be pleaded.

This brings me to the only practical suggestions which I shall venture to give. I have made the proposal that some style should be adopted as a beginning; it might be the Gothic, but the particular style is, I think, of small consequence. The process should at once be commenced of weeding out all shams, for I go on the assumption that here, as in life, "honesty is the best policy." Let all forms which are not suited to our present wants and conditions be rejected. The same should be done with all constructive forms which are not natural, or which, in other words, would be bad building if produced with the material employed. There can be no good architecture without good building; this is of the first necessity. No structural form should be added to a building which is not required, and with no other object than that of "architectural effect." This has been a prolific cause of shams. Such things as pinnacles, turrets, towers, and all sorts of useless excrescences have come into existence under this supposed necessity. Does an Imperial Institute require a tower? I am not acquainted with the requirements of an Imperial Institute. The building to be erected at South Kensington is to have one, and a high one, too, but, knowing how architectural designs are made, I do not look upon this as evidence of the need for such an erection. A belvedere is a good and in many ways a useful addition to a house. Were I a rich man and could build a residence, a belvedere would be one of its features; but it would not be an addition merely for "architectural effect." All decoration which is founded on, or the representation of, previous constructive forms, to be rigidly avoided; and originality in design should be understood as the aim of all decorators; originality in art is a scarce article. Many will manifest the power, if the way is open, but not if the highest ideal is only one of making a servile copy of what has been done before.

I have given these suggestions not as all that is required, for this paper cannot pretend in any sense to be exhaustive, but as containing some of the main guides to be followed.

I would ask of my hearers to think the subject out more fully in their own minds; the recognised canons in literature and art should not be lost sight of; if they are accepted they will be found to be good guides in reference to this question of style in architecture. I feel sure that architects must change their method; they must adopt those rules which have led to high results and fame in other walks. They have been on the wrong road, and their labour has been nought. I have often heard it said that the people of this country were incapable of producing good architecture—meaning by this that we had some defective sense or another. This has never been my belief. Failure is not in itself a good ground on which to justify such a grave charge. If I show that another cause exists, sufficient to account for the want of success, this charge is disposed of. We have excelled in other spheres of art, and there can be no reason why we should not excel in architecture. Time will be necessary. "Rome was not built in a day;" and a style of art cannot grow up without many failures; but work, with patience, will succeed at last.

I consider this paper as a contribution to the Section of Applied Art in all its branches. "Design" in art cannot be copying. The word speaks for itself.

In conclusion, I may be permitted to state again that there is no intention in this paper to assume that I am presenting anything that is original. It has been all stated before. I have recommended my hearers to work out the question for themselves; and in doing this I would recommend the works of John Ruskin. I read them long ago, and followed him as my guide. I have not re-read Ruskin's works to help me in this paper, but I believe that the main ideas which are here given will be found in the works of that writer. I need scarcely say how much more fully he explains and illustrates them, and that he enters into regions of thought connected with the subject on which I have not ventured to touch. Lately I have heard almost nothing about John Ruskin's works, except that of the high prices which the original editions are rising to; one would prefer to hear that the books were being read. Had they been followed, the architectural problem would have been by this time on its way to a solution.

DISCUSSION.

The CHAIRMAN said, when he was asked by Mr. Simpson to preside on this occasion, he had not the least idea what kind of paper it would be, but knowing Mr. Simpson as he did, he knew it would be an interesting one. No doubt the writer spoke his mind very freely, and must certainly be considered a *candid* friend, and with something of the feeling which dictated Isaac Walton's advice to the angler, when putting a worm on the hook, to handle him tenderly as if he loved him. He thought that was somewhat the feeling with which Mr. Simpson had written his paper, which he was sure would lead to a useful discussion, though many gentlemen whom he had hoped to see were unable to be present. Mr. Stephenson had written to say that, in his opinion, "the Queen Anne style was not the result of copying, but was only the outcome of London materials and current modes of work. The straining after originality for the sake of being original, when we have the thing done to our hands, is affectation, and in the result generally bad."

Mr. WILLIAM WHITE said the subject of this paper had been present to him all through life. It was true he had persistently followed the Gothic style, which had been pronounced a failure, but he did not by any means say that it was the only style which ought to prevail at the present day. It was hopeless in these days to expect the development of a style which should be distinct from all that had gone before, unless they began *de novo*, and worked it out from definite principles. The architect had now much greater resources at his disposal in the way of materials, and facilities, and power of doing work than ever before, and all this necessarily precluded the exact imitation of which Mr. Simpson complained. The cause of the failure in the revival of the classic style was that all the examples produced as precedents were temples or other public buildings, such as were very seldom required now, the vast preponderance of our architecture being of a domestic character. When these dwellings were properly and consistently built with anything like a style, they might hope for real success in public buildings, and it was in such large buildings alone that anything like a pronounced style could be expected. Only in the monumental architecture of the country could they hope to accomplish anything noble to hand down to future generations. This had been the success of Gothic architecture. Our village churches, and large cathedrals, had come down to us from early ages. Our associations had been gathered around them, and they were the first instances of architecture to attract men's minds. The purposes for which churches were required were the same now as in the 11th and 12th centuries, when the noblest buildings in that style were erected. What was called eclecticism he considered the most pernicious thing in modern architecture. Mr. Simpson spoke of the eclecticism of elimination, but that he thought was a mistake. The elimination of faults, or of that which was incompatible with the construction

and requirements of the present day, was a wholly negative eclecticism. But what he objected to was taking a little bit from one style and a little bit from another, and putting them together without a due sense of harmony, fitness, and, above all, repose. That was the one quality which characterised all our ancient buildings, and it impressed the mind more than any amount of originality. It was perfectly true that a man ought to have some originality, but it ought not to be devoted to the production of the sensational, but to true, proper, and legitimate treatment. It would be perfectly original to turn the base of a column into the capital, and use the capital for the base, and things quite as absurd had been done, but that was only spurious originality. It seemed to him that it was impossible, and would be wrong to attempt architecture at all, without a historical knowledge of all that had gone before. The revival of literature which had been referred to had its rise in the going back to Classic literature; but when that was acquired, men did not find it sufficient to express their ideas, but it led them on and enabled them to express their ideas in their own way. So it was with the revival of Gothic architecture. Who was the reviver of it? The answer was—Scott; but it was not Sir Gilbert Scott, but Sir Walter Scott, who disseminated the ideas throughout England which first of all occasioned it. They wanted not a lot of schools, but a college of architecture, where all the numerous schools should be united, in order that they might work on a definite and progressive principle, if they hoped for any permanent success.

Mr. BLASHILL said he had been familiar with this subject for thirty or forty years, and should not say how many speeches and lectures he had heard upon the coming style, but he never heard one which in the least foreshadowed the future or gave him any idea of what was actually coming. Whether the prophets of the present were likely to be more successful than those of the past he could not say. Many gentlemen had told them what not to do, and they generally turned out so far pretty correct; but it occurred to him that if they were to meet together on such occasions for any purpose it was to bring about some practical result, and the question was what kind of advice should be given to those who were responsible for the future of architecture? Was it at all likely they would ever settle into one uniform style, as in the days of ignorance, in the sense that practitioners in former times were ignorant of any style but their own? He did not think it was, except under very exceptional circumstances. One would be more attached to one style, and one to another, and that would probably go on for a much longer time than it was at all useful to look forward to. Whether the competing thoughts of many minds would ever bring things to a kind of focus, so that every one would think alike, was very questionable. The only course at present was to follow a good deal what Mr. Simpson had told them, to avoid shams, and more particularly to turn their attention practically to the things they knew to be wanted. The architect should keep in the closest possible touch with his client, and get to know what he wanted—not that he always knew himself—and in a certain sense teach him, but not foist his own opinions on his client to his injury, either in pocket or convenience, simply for the sake of what the architect might think a good appearance. The idea which had been brought forward by Darwin in his great book had had an enormous and far-reaching influence on science, and would probably affect the progress of art; by strict attention to the wants of the age, by thorough knowledge and a conscientious application of materials, some approach to uniformity would arise; there would be a dropping of useless forms and a development of usefulness, leading to a survival of the fittest in architecture as in nature. He should feel more interest in discussing this question if he could think it was one which was generally interesting to anyone; or that the public thought it of much importance what style of architecture was followed; and especially if he could see that buildings were properly cared for, duly respected, kept clean, and protected from injury; in short, that the public thought as much of them as they did of pictures, and as some did of sculpture. There was a building at the corner of Buckingham-street, designed by Mr. Gray, which thirty years ago he and others used often to admire, being one of the first specimens in London in which coloured material was worked out very beautifully. It was a long time since he had seen it, but when he did it was almost impossible to detect any of those beauties which he had seen in years gone by. It was all due to the absence of cleaning, and neglect, which had led to this building suffering as every structure must in London. It was useless to think of getting an attractive style of architecture as far as the metropolis and the large houses were concerned until people learned to take more care of buildings when they were erected.

Mr. ALEX. PAYNE thought Mr. Simpson had rather forgotten that a style of architecture had not been the invention of one or the two great men or any particular age, so much as a natural embodiment in stone of civilisation. Wherever you found a new civilisation, and especially a new religion, you found going with it a particular style of architecture. For instance, the Egyptians had a peculiar mystical religion, and their temples and other buildings must be taken as the embodiment in stone of their religion and civilisation. The Greeks, again, reached the highest development of culture and refinement in art, and in the magnificent style of architecture they developed you had the embodiment of the Greek character and religion. Coming to Rome, he did not consider there was any real difference between the Roman and the Greek religion, and practically their architecture was the same. When a new force was thrown into the world, such as Christianity, it began by trying to

work on the old lines, but gradually broke away and developed a new style, the Gothic. The same thing happened with Mohammedanism, which had the Saracenic style. Now the civilisation of our own time was a mixture. Most of the politics and history taught in schools was derived from Greece and Rome, and the religion from Christianity, and in architecture there was the same mixture of the Classic and Gothic styles side by side, with a preponderance sometimes of one and sometimes of the other. One speaker referred the revival of Gothic to Sir Walter Scott, but he should rather refer it to the High Church movement, the great effort of which was to bring people back to the state of feeling prevalent in the middle ages. That movement was now flagging, and, concurrently, the Gothic style was going out. In the mis-named Queen Anne style, in which you found the elasticity of the Gothic mixed with much of the refinement of detail of the Classic style, there was a mixture of styles due to the concurrence of two systems of thought. There was too much admiration of everything which had been done before, and a want of appreciation of the advantages we now possessed. In the present day the cathedral, or temple, did not occupy such an important position as it did in the middle ages; we were not so much bound up in the life of the church, or in a particular building; it was the domestic life which was most highly developed. He would ask any one who had a strong leaning for Classical architecture, how he would like to change the modern style of living, and the comforts of an English home, for the ridiculous little hovels which were gathered round a wealthy Roman's palace. In Pompeii you found a grand court in the centre of the building, but the master of the house and his guests were content to sleep in a hole hollowed out in the wall, so short that he could scarcely stretch himself out at full length. Domestic architecture was the great feature of the 19th century. With regard to the future, they could not alter modern civilisation or modern style, and he quite disagreed with what was said in the paper about originality. The bane of the age was the thirst for originality, and the constant running about after one style and then after another, instead of keeping to one good thing. If, instead of that, when they had a building to design they would ascertain what kind of building the client preferred, and then taking some fine example of that as a model, and endeavouring to improve upon it to suit the requirements of the day, better results would be obtained. A Gothic style seemed best suited to a church, the Classical for municipal buildings, and for domestic buildings they would naturally go to the Elizabethan, as being the style developed by the needs of domestic life in England. By keeping within those lines they would be more likely to make progress than by continually making a fresh start.

Mr. BLACKIE (Glasgow) said the last speaker had spoken very well on the influence of religion on style, but in modern times, especially since the 16th century, the influence of religion on style seemed to have ceased; and there was more scope in building churches for development of style than in almost any other class of building in this country. The purpose for which the great old buildings were erected was spectacular and processional worship, but what was required in a Protestant church was a building in which a number of people could be seated comfortably, and where each one could see and hear a speaker placed at a particular point determined before hand. Now the Gothic style provided a long house, with a transept for catching and diverting sound, and frequently with broken lines and dormer windows, and the result was that the proportion of churches in either the Classic or Gothic style in which it was easy to speak or hear was very small. In churches with a transept there was almost invariably a portion of space which was wasted. Those which had been successful were mostly those which were shorter than usual, and had the ends or corners rounded. The Gothic provided you with a suitable type if you liked to accept it; you had an apse and a baptistery which might be extended if desired. The number of Gothic churches in which you could hear was very small, simply because it was supposed that you must have a transept. The utility of the structure was sacrificed to the following of a style, instead of taking the style and making it suit the requirements of the house, and if it would not suit, putting it aside.

Mr. TARVER said their thanks were due to Mr. Simpson for giving them a good many points to think about, but in many respects it would be obvious to the Profession that he had been flogging a dead horse. A great many things which might have been true twenty years ago hardly needed so much comment now. Mr. White had inveighed against eclecticism, but he should like to know any old style which was not eclectic in its early periods. Instead of speaking of the copying found in old styles, he should prefer to use the word *absorption*. What the old men did, and what we ought to do, was to absorb anything useful, and to reproduce it, when suitable to modern requirements. An exactly similar feature might be found in two utterly distinct styles of architecture. On referring to Mr. Dunn's book they would find on one page a Saracenic building, carried by some corbels, precisely similar to the corbels in a totally different building on another page, in perpendicular Gothic; that particular form was appropriate to each building, and was thoroughly at home in each. He always thought there was a danger in being sketch-book architects; going for a tour, being highly delighted with what they saw, coming home, and putting their sketch-book on the desk when designing a new building. It was almost as great a danger as in having what was called a "crib-book" by their side. He yielded to none in his admiration

for old work, but if once you began to copy you did not know where to stop. It was far safer to shut up all books when designing, though it might be well to revise the design afterwards by comparing it with some good examples. There was no vain conceit in refusing to copy styles which, by common consent, all admired. They should be so proud of them as to avoid discrediting them by imitation. In altering old buildings, they should show respect for each phase of old work, by preserving it—not by adding to it in exactly the same style. Any new work should be as distinctly of our day as every bit of old work was of its day. Despair of being able to do this supplied the Society for the Protection of Ancient Buildings with the only valid excuse for its existence. That society had very rightly raised its voice against restoration for its own sake. When an architect went to see a church, and said, "Such a portion is missing; it was evidently originally in such a style; I will restore it for you"—it was right to protest. But it went further, and added a sentimental protest against touching any old building at all, except for the mere purpose of shoring it up, and that he could not agree with. We had as much right to enlarge our churches for our own use as our forefathers had for theirs. Coming to the question of the paper—what style ought to be followed?—he was bold enough to say that they had a domestic style, that they almost had a civil style, and he hoped that in due time they might have an ecclesiastical style. All the old styles were formed by absorbing improvements as they arose. During the last twenty years a good deal had been done towards forming a domestic style of our own. He maintained that the period when most of these buildings were erected was obvious on the face of them, and many of them were very pleasant to look at. It would be invidious to pick out any particular examples, but one which he had often noticed was the Penny Bank in Victoria-street. Architects should be especially careful in absorbing elements from a very vast collection, especially in church architecture which included so much that was traditional, and was not to be lightly set aside. Sir Christopher Wren had shown how to absorb traditional features, such as spires, into the style of his day A revival of Classical architecture was the style of his day, and he followed it, but it was perfectly easy to distinguish one of his churches from any Greek or Roman buildings. He thought, if architects would agree that horizontal lintels, semi-circular arches, and refined detail were in sympathy with the general feelings of the present day, that we had a soil which could be made to absorb any useful seed that might be sown in it, and bring forth wholesome fruit.

Mr. Woodward thought Mr. Simpson would have not only the public but architects with him to a great extent, and they would have been still more indebted to him if they could have obtained practical guidance from the paper. During the reading he had been trying to evolve a new style, and he thought, if he had a building to design, he must have first a doorway, which would be, say, 5 feet by 10 feet. Suppose instead of putting the 10 feet vertically he placed it horizontally; then, coming to the windows, he reversed the ordinary proportions, or as Mr. White suggested, adopted the base of his pillars for the capitals. He should in so doing certainly be original, and would be evolving a new style, but he doubted if it would be satisfactory. He did not see why architects had been accused of copying more than painters or sculptors, all of whom were more or less successful copyists of nature. The great thing was to attend to the wants of the day, and not to sacrifice convenience to style. "Design with beauty, build with truth." He thought it would be a fatal error to separate the scientific from the artistic branch of architecture. Such a thing was impossible, the two being intimately related, and the structural requirements often giving the artistic quality. He could not agree that there had been three centuries of nothing but copying. In those three centuries they had had St. Paul's Cathedral, the Houses of Parliament, Somerset-house, Sir James Pennethorne's work in Burlington-gardens; and the Bank of England. These buildings all had a distinctive style, and though there was a feeling in them of what had gone before, it was not true to say they were mere copies. With regard to the so-called Queen Anne style, he went with Mr. Simpson absolutely, and should even go farther, for to his mind it was the very embodiment of ugliness. Low doorways, to give the idea of humility, their designers said, nooks and corners, long narrow windows, with large bars shutting out the light, and with small panes, copying what was done when large ones could not be obtained; gawky chimney stacks, and wasteful expenditure on what were called picturesque roofs, were the chief characteristics of this style. He agreed with the author that it was painful to walk along a Parisian boulevard or street, and see a long line of cornice unbroken from end to end; and whatever alteration there might be in the municipal control of London, he trusted that, with due limitation on the height of buildings in reference to the width of thoroughfares, architects would have every opportunity to impress upon each building their own individuality. He thought Mr. Simpson had gone rather too far in his condemnation of copying pediments; a pediment was a very pretty termination to a doorway, and was useful in throwing off the rain. He did not quite know the building referred to near the Temple Station, but if it was the one he thought it was, it was the work of one of the most distinguished Gothic artists of the day, and he should be much astonished if the gargoyles were mere useless shams. They could not hope for any new style, but any man, whether of the Gothic or Classic school, who honestly set to work to design what was best for the exigencies

of the day and the extent of his clients' pocket, would succeed in giving the public what they desired.

Professor KERR, who was unable to be present, sent the following remarks, which were read by Mr. Kerr, jun.:—I have had the paper read to me, and recognise in it an unusual amount of thoughtfulness and practical good sense. It is always to the advantage of the profession of architects when an outside critic, animated not by mere censoriousness, but by enlarged views of men and things derived from travel and experience, offers such comments as those of Mr. Simpson upon the difficult questions which surround the problem of artistic building. But those questions are much more difficult than they are generally supposed to be. As regards working architects, Mr. Simpson is quite right in saying that they are too much occupied with business to attend to philosophy. At the present moment, in England, there is a great deal of architectural work being done. Much of it is good work, although probably it will not make its mark in history; a great deal of it is mediocre work; and not a little of it may be bad work; but we must not imagine that any age ever existed in which there was not a considerable amount of mediocre work, and a considerable amount of bad work. English architecture is highly esteemed abroad; this is a circumstance which most people here are not aware of. English art at large is, in my humble judgment, coming to the front at last. I see no reason yet to change the conviction which I have entertained for a good many years past, that in the next generation England will, to a great extent, lead the world in artistic matters; and in architecture this is, I think, already becoming apparent. The quantity of our architectural art is large in the aggregate; and it is not necessary, for the moment, that its individual examples should be on a grand scale. Grand building is not a characteristic of this age; certainly not in England. As for the "Battle of the Styles," I regard that episode as having been much more creditable than otherwise to all parties concerned; it was an honest, rough-and-tumble contest between two rival principles, both of which were of great value, and still are. In fact, the contest is not, I hope, by any means yet concluded. The question at issue was, and still is, this—what is the natural style of architectural design appertaining to the present period of English History? On the one hand, it was contended that England, as part of Modern Europe, must follow, by mere force of natural law, some form of development of the Neo-Classic mode, which had its birth in the 16th century—when modern Europe had its birth—in Italy. This is the style, for example, which has pursued an uninterrupted course of development in France, and in Italy itself. But, on the other hand, it was contended by many that England, owing to her peculiar traditions and traditional life, ought to follow in this respect a course of her own, referring back to earlier times; and it is this idea which lay practically at the root of the Gothic revival. The Battle of the Styles was a conflict between these two great principles; and the remarkable success of the Gothic movement was, in my opinion, a thing of which English artistic history is entitled to boast. The movement was wholly English, and its success was entirely characteristic of England. It would be a mistake to suppose either that the movement has yet subsided, or that its success has yet abated. Secular Gothicism, at any rate, may have ceased to be practised; but the vigorous vitality of our new interpretation of mediæval principles is, at this moment, almost the backbone of our best architecture, and of all other applied fine art. We must, however, always remember that architectural style is a matter of slow evolution; it comes from no man's *fiat*; by no concerted movement of individual opinion; by no act of will in any form; but by the unconscious action of natural laws which nothing can coerce; and every country in every age has had, and always will have, its own style of architecture, as the product of the peculiar conditions of that country and that age. I might say a great deal about the peculiar conditions of the modern mind with respect to the aims and objects of building; and there is nothing in modern architecture that cannot be explained in this way. For instance, strong times produce strong architecture as well as strong men, and weak times produce weak architecture as well as weak men. Architecture has been called "History in Stone;" and so it is, alike in good, bad, and indifferent. Therefore, it is not only unlikely, but absolutely impossible, that any consultation or combination of designers could be made to conceive at the present day a new style of architecture proper to the occasion. The style or styles, or conflict or confusion of styles, actually reigning, is that which necessarily reflects the spirit of the age; and the only thing which I think we are competent to do just now, in the direction of improved architecture of any philosphical kind, is to wait patriotically, in the hope, which I have hinted at, that in the days that are coming our children are destined to do a great deal better than ourselves, and to make a mark in history sufficient for their own honour and for ours.

The CHAIRMAN, in proposing a vote of thanks to Mr. Simpson, said that though he had said a good many hard things of architects in the paper, no one had said anything in the discussion which could give him pain; his remarks had been taken in the kindest possible way, and every one had given him credit for the best intentions—for a love of art, and for a wish to improve the study of it. He thought that every one present would agree that it would be useless to attempt to lay down anything very definite in the way of style. They must first study the wishes of their clients, and having ascertained the exact form of structure which would best give the result desired, that same form would, to a large extent, give the outline of the

design. Within this last century there had been a great development of style; after Sir Christopher Wren had given us his grand outlines of towers and spires, there came that phase of art which Mr. Simpson had described as applying to large mansions—a Classical building, with a centre and two wings exactly balanced, and the result was, as everyone knew who had been over any of such buildings, that you had rooms in one part of the house which ought to be 8 or 10 feet high, but which had to be 15 or 20 feet, in order to accord with those on the other side; and there you had a large amount of space which was worse than useless. At the beginning of the century men began to rebel against everything being sacrificed to uniformity. Then they began by taking the Gothic as a basis, which was our national style, and gave them more freedom. Supposing it were agreed that the pursuit of Gothic was a failure—still, they had gained something from it—the gable, and freedom of design, which allowed, *e.g.*, the use of rooms in one part of a house on a different level and different size to those on the other. It was a gain in picturesqueness, and an immense gain in convenience; they could introduce picturesque chimnies, and those bow windows which formed so admirable an adjunct to the outline of a house. Gothic, then, was gradually given up in favour of that style of which he would speak more favourably than Mr. Woodward — the Queen Anne. By that they gained picturesque effect in the way of gables, which were not put up merely for ornament, but because they were wanted, and they also gained colour, and the improved result in this respect might be very well seen in some old street almost entirely built in compo, where one or two new houses had been built in this style. There was also perfect freedom in construction. It was often accompanied no doubt by a vast deal of detail, which was about as bad as it could be, and unfortunately the bad features were copied as well as the good. But a clever architect could give in that or any other style very pleasing and picturesque outlines, and his fear was that in so doing the beanty of details was too little studied. The only point on which he thought they would all disagree with Mr. Simpson was in the recommendation that the decorative part of architecture should be separated from the constructive. He did not think any architect would fall in with that idea, for the construction, if carried out honestly and well, gave to a large extent the character of the whole design.

The vote of thanks was carried unanimously, and the meeting adjourned.

Mr. SIMPSON, who had been suddenly called abroad, and therefore was unable to be present at the meeting, has sent the following reply in respect to the various points raised in the discussion:—I have to state that I am fairly well satisfied with the discussion; I understand that most of the gentlemen who spoke are architects, and the principal ideas expressed in my paper were more or less supported by them. Many objections were urged, in some cases I think my notions were not quite realised; probably I may have failed to put them in a clear enough form, or the speakers, only hearing the paper, may not have caught the exact meaning. Professor Kerr, who wrote his remarks from reading the proof—and he has evidently done so with care—has followed my thoughts very fairly, and I thank him for his very appreciative remarks. I perfectly agree with what he says about the "Battle of the Styles," and that it is not yet finished. I am said to have been hard on the architects; perhaps I have been, but I think I have given them praise wherever they deserved it, and Professor Kerr gives me the opportunity to say something in their favour. He says that English architecture is highly esteemed abroad. I can confirm this by putting it in another form, that is, that we are ahead of foreign architects. This has not been my first visit to Berlin, and while there on this as well as other occasions, I have used my eyes as I walked through the streets; there are many very fine houses, but the architects have not yet got free from the Classic traditions, and much uniformity is the result. But there is still worse behind. I was in the western part of Berlin one day during my late visit, where there has been within the last few years a great deal of building going on. These were large and fashionable houses, covered with flashy ornament, which I took to be built of stone, but I came on some houses unfinished, the brick carcases, on which I discovered, much to my surprise, the ornamental work had yet to be put on with cement. Berlin, it will thus be seen, is still in the "compo" period of street architecture. What Berlin wants, including many other places on the continent as well, is a Gothic revival and a "Battle of the Styles," to wake the architects up. It was the Gothic revival which has placed our men, or at least a number of them, in advance. It did this by freeing us from trammels; and it was one of the objects of my paper to point out how so many of our architects are yet under similar trammels, and that it is only by getting quit of these that freedom can be obtained in order to advance in the evolution of a style. It was with this object in view that I dealt with the all-important question of "copying" and "designing." I was afraid I had said too much on that subject, but some of the remarks show me that it is one part of the "dead horse" that will yet require a good deal of flogging. Mr. Stephenson talks of "straining after originality for the sake of being original." Well, that is not my idea of originality; the man who is favoured with this divine gift does not require to "strain." Mr. White proposes to reach originality by reversing the position of the base and capital of a column; but he very wisely adds that this would be "spurious originality." I refer Mr. Woodward, with his door 5 ft. high and 12 ft. wide, to that critical remark. The relationship of architecture to painting and poetry seems scarcely

to have evoked any attempt on the part of the speakers to deal with that point of view. It controls my views to a large extent. It was only the merest sketch I was able to give of this aspect of the subject. I would request readers of the paper not to overlook it. It was when authors escaped from the Classic influence, and when painters went to nature instead of to the Italian masters, that each began a new life. The lesson this teaches to architects is very plain. Mr. Phené Spiers, in a letter to me containing a number of comments, says that architecture cannot be compared with painting and imitative art. I am sorry here to differ from such an acknowledged authority. It is the æsthetic part of architecture which raises it to the dignity of a fine art; and it seems to me that what is æsthetic in architecture must be under the same conditions as æsthetics in all the other branches, which we know under the term fine arts. Æsthetics, or a sense of the beautiful, enters largely into literature. Why should the creation of the beautiful be a different question in architecture from what it is in literature and the other arts? I would suggest that it is because architects have partly fallen away from this sisterhood of the arts that they are so behind; and that it will only be by accepting the canons which are so well recognised in literature and art that they will be able again to come to the front. Mr. Blackie's remarks on the plan of our churches, although only referring to a matter of construction, is an important one. I had it with other matters in my mind while writing my paper, but space prevented any reference. I have always thought that a much better form could be obtained. Mr. Phené Spiers calls my attention to the iron girder as a material that is likely to have an influence in future building, and that it will tend to produce the horizontal form instead of the arch. In this I think he is right, but it does not in the least affect my remarks about the arch being better than the lintel where brick and stone are employed. There is much in the discussion to which I might add further criticism, but I will limit myself to restating the general position of the question. From my point of view only negative positions can be given. Such being the case, those who came to hear this paper expecting that they would have the style to be followed put before them, must have found themselves disappointed; no man, or body of men, can sit down and produce a new style. Thfs can only be done by a course of development requiring time, during which the requirments of the period and the building materials should be the dominating factors; this will produce the constructive forms by a natural process. Then follows the æsthetic or decorative function, in which the artist should be a designer and not a copier. To achieve what is here pointed out the ground must be cleared, the clogs and fetters of previous styles must be removed, so that there may be perfect freedom for the new growth. The old styles have stood in the way, and prevented the advance of a new one; only let us get quit of these prepossessions regarding what is of the past, and our men will soon find their way on the new road. Many of the speakers in the discussion show that they still linger among the tag-rags of former styles; while that is the case the dead horse must be flogged, and it is the duty of every man who has any love for architecture to speak out, so that the art may be permitted to advance to that high position which it is entitled to hold among the sister arts. My final words will be that I feel how little I have said out of so much that might be said, on this, which is of such vital interest to the future of architecture.

Miscellaneous.

*SOME OF THE APPLICATIONS OF PHOTOGRAPHY TO SCIENTIFIC PURPOSES.**

By H. Trueman Wood, M.A.

I do not know that there is much need, in addressing such an audience as this, to lay stress on the important part now taken by photography as an instrument of scientific research; but I do think that our annual Conference should not be allowed to pass without stock being taken of the present position of photography as the handmaid of science. I think, also, that too many photographers are content to regard photography merely as a means of making pictures. With professionals this would be excusable, but amateurs ought to make it their first object to advance the science to which they are devoted, and to promote its application to as many diverse purposes as possible, thereby increasing its usefulness.

All that I propose to do on the present occasion is to summarise, quite briefly, so far as I have been able to collect them, the various scientific applications which have yet been made of photography, and to indicate the special advantages which can be obtained by its use.

First of all, photography is an absolutely unprejudiced observer; it has no personal equation. The sensitive plate records, with absolute fidelity, the image thrown upon it. We may be mistaken in our interpretation of the record, or in rendering it visible we may not treat it so as to get the plainest and best results—but that is our fault. And we can, if we like, falsify the record, but that is our dishonesty. Therefore, as a scientific witness of form, when it is available, photography is invaluable.

The next, and perhaps the most valuable characteristic of photography, or at least the one by which the most remarkable results have been attained in its application to astronomy, is the power possessed by the sensitive surface of storing up feeble impressions of light, so that an image is produced by the

* Paper read at the Photographic Conference, March 13, 1888.

long-continued impact of vibrations too feeble to have any effect until they have been allowed to mpinge upon the plate for a considerable time.

On the other hand, the light rays, if of sufficient energy, can, as we know, produce their due effect in a time which, to human appreciation, seems infinitely small. Thus, photography can observe and record the successive positions of a rapidly-moving object, whereas to the eye the successive movements are, by the persistence of human vision, blended into a sort of general average, as in the case of a galloping horse, or lost in confusion, as in that of a rapidly-spinning wheel.

Again, the photographic plate may be said to have a greater range of vision than the eye. It is affected by rays to which the eye is quite insensitive, and thus by its aid we can take cognisance of, and observe, rays beyond the limits of the visible spectrum, of the highest and of the lowest refrangibility.

Then the photographic lens is, of course, indifferent as to the amount of detail which is set before it. Thus, a large extent of surface can be observed, and its details recorded at once. In a short series of exposures, the lines of a spectrum, which it would take months or years to map by hand, are recorded with an accuracy the hand could never hope for. In mapping the heavens, the exposure of a single plate may give better and more trustworthy result than six months' such toil as that to which the two Herschels devoted years of their lives. And in a few moments there can be accumulated data which may suffice for the examination of years. Thus, the few minutes of an eclipse may provide work for months.

Probably the most important services which have been rendered by photography to science are in the domains of astronomy. Very early in the history of photography, attempts were made to photograph the moon by Professor Draper, and later on, in 1852, photographs of the moon which have hardly yet been surpassed were obtained by Mr. Warren De La Rue. For some time, photographs have been regularly taken of the sun's surface; indeed, of recent years, a photograph of the sun for every day of the year has been obtained from some part or other of the earth. The exposure for them is made by a very narrow slit, passing rapidly across the field of view. The value of photography in the short period of time available for observation during solar eclipses is well known since the eclipse of July 18, 1860. The most recent achievements, however, have been in connection with sidereal photography. This may be said to have been commenced by Dr. Gill at the Cape of Good Hope Observatory in 1882, and immediately after the publication of the result astronomers perceived the value of photography for star-charting. This work, an undertaking of enormous and lengthened toil when it has to be done by eye observation, will certainly in future always be carried out by photography alone. You are aware that Messrs. Paul and Prosper Henry have been for many years working at this important subject, and they were getting into considerable difficulties in carrying it out, when the results obtained by Dr. Gill determined them to employ photography. In 1886 it was proposed that an International Congress should be formed to carry out a survey of the heavens. The first meeting of the congress was held in April, 1887, and by it arrangements were made for charting more than 20,000,000 stars. It is expected that the charting of stars down to the 14th magnitude will be accomplished in about five years. Ten thousand plates will be used, each exposed for a quarter of an hour; while there will also be a set of short-exposure plates to deal with the brighter stars, which will, of course, be over-exposed in the first set.

No reference to sidereal photography could be made without allusion to Mr. Common's well-known photograph of the nebula in Orion, taken in 1883. Of this photograph the director of the Lick Observatory says that every important result reached by twenty-four years' study of the nebula in the great Washington equatorial, was obtained by Mr. Common's photograph, which was exposed only for forty minutes; while Mr. Norman Lockyer has expressed the opinion that this photograph is one of the greatest achievements of modern astronomy, of a value greater than that of all the eye observations made during the past two-and-a-half centuries.

As regards astronomical spectroscopy, here, of course, photography has had it all its own way. Dr. Huggins was pioneer in the work of photographing star spectra in this country, and he has been followed by Dr. Henry Draper and Prof. Pickering in America. By means of spectroscopic negatives, not only has much information been obtained as to the constitution of the stars, but we have also learned much about their motion. The latest published work in this direction is that by Mr. Norman Lockyer, who has applied Mr. Francis Galton's system of composite photography to the spectroscope, and has, by the combination of negatives from portions of meteoric bodies raised to incandescence, obtained spectra identical with certain stellar spectra, and has thence deduced the conclusion that the material of the stars and of the meteoric bodies found upon the earth itself are identical.

Meteorologists have made use of photography in various ways. Its most simple application has been its employment in self-recording instruments. The mercurial column of a barometer or a thermometer has been caused to intercept the light falling on a band of sensitive paper passing behind the instrument at a known rate. A curve is thus traced which accurately represents the variations of the instrument from hour to hour. Or a ray of light is reflected by a mirror on a similar band, the mirror being caused to move by the instrument whose variations it is desired to record. Or to measure directly the amount of solar radiation, a ray of light passing through a small aperture in a closed cylindrical chamber, and falling on sensitive paper lining the inner surface of the chamber, traces, as the sun

moves, a line whose varying intensity is a measure of the variation of the solar light. Such photographic records have now for a considerable time been employed at Greenwich and at other observatories. The photographic observations of cloud forms and distances made in this country by Mr. Whipple, and in France by M. Jansen, have also, I understand, proved valuable.

Recent photographs of lightning have quite disposed of our old friend the "forked" or zig-zag flash, which will doubtless, for the future, only appear in the pictures of artists who are superior to the realities of nature, along with pink rainbows, or rainbows with the red inside the arc. They also serve to show the similarity of the lightning-flash to the spark from a powerful induction machine, photographs of the two being closely alike.

In the domains of chemistry and physics, the best photographic work has been done by the camera when allied with the spectroscope. Without the aid of photography, comparatively few results would have been obtained by the use of that marvellous instrument. Indeed, if the spectroscope is ever to attain the position which has been claimed for it as an instrument for practical chemical analysis, it will certainly be by the aid of photography; and there is every reason to believe that, thanks mainly to the labours of our distinguished chairman (Captain Abney) and of Prof. Hartley, amongst others, the practical application of the spectroscope for purposes of analysis has been rendered possible. Not only can useful practical analyses of metallic substances be made by the spectroscope, but by photographing their absorption spectra, even organic substances have been caused to give useful results. It has been proposed—I am not aware with what success—to employ photography to record sound, by photographing a jet of water interrupted by the action of sonorous vibrations on a diaphragm. Some day, perhaps, photography will give us a standard of light; perhaps when we can ascertain the amount of silver reduced by a definite amount of light acting on a measured surface of a known sensitive compound.

In the biological sciences the applications of photography have been many and various. I need say nothing about its services to medicine, as this subject has been specially treated by Dr. D. G. Thomson. So I will only refer to the facts that, as I believe, photography has been of service in recording the appearance caused by various diseases, and that photographs have been successfully taken of various portions of the human body—such as the retina and the interior of the throat—presenting special and great difficulties.

Anthropology finds a valuable aid in photography. Year by year one savage race after another is disappearing from the earth, or altering its ancient habits or mode of life. It is only by photography that a trustworthy record can be obtained of these vanishing types. Whether any useful result has been, or will be, obtained by means of Mr. Galton's well-known process of composite photography, I cannot say. At all events, it will be a pity if so singularly ingenious a device cannot be made to serve some useful purpose.

In the study of natural history probably the most important work done by photography lies in the direction of photo-micrography—a branch of microscopic work which has made great progress of late, and will doubtless make more. I believe that a considerable step forward has been made—at all events, as regards the higher powers—by the use of objectives of the glass lately introduced by Professor Abbe. Nor must we forget the most interesting work commenced by Mr. Muybridge, and continued by M. Marey, in photographing animals in motion. The researches of these two gentlemen have done more to throw light on the actual phenomena of animal movement than the investigations of all preceding naturalists put together.

The value of photography in geographical science is now so well admitted that an explorer would almost as soon think of starting without a camera as without a rifle. Consider how valuable are such photographs as those of the wonderful terraces which existed in New Zealand till two years ago. What other record have we of what travellers tell us was once the most marvellous natural phenomenon in the world? How useful, too, are such photographs as those of the Arctic expeditions, how interesting the pictures we now get after every new journey into unexplored or little-known lands!

Such are some, at all events, of the services which photography has rendered to science. I have been content to enumerate rather than to describe them. I have confined myself to scientific applications alone, leaving aside those of a technical or legal character. I cannot hope that even the enumeration has any pretence to completeness. Perhaps some of the omissions may be supplied in the discussion.

BULGARIAN WINE INDUSTRY.

The *Bulletin du Musée Commercial* publishes a letter from the Belgian Consul-General at Sofia, in which he states that there are about 172,000 acres of land under vine cultivation in North and South Bulgaria. The yield per acre varies between 250 and 350 gallons, two-thirds of which is red wine and the remainder white, the latter approaching in quality to the Hungarian ordinary white wine. Nearly all the vines produce a wine rich in saccharine matter, but, unfortunately, the preparation is effected in a very primitive manner, and it frequently happens that it is entirely spoilt. It is said, however, that the wine produced in certain vineyards is not inferior to the best natural wines of other European countries, and it may be for this reason that Bulgarian producers here so frequently received honourable mention at the various exhibitions. At the present day considerable quantities of Bulgarian wines are being largely

bought for European markets. In 1886, the quantity of wine exported from certain districts in Southern Bulgaria amounted to 140,000 gallons, chiefly to the South of France, where these wines, it is said, are subjected to a certain manipulation, and sold as the products of the country. It is only of recent years that the cultivation and production of the vine has attained any considerable proportions in Bulgaria. Formerly the population of this country looked upon viticulture as a most unimportant industry, and farmers cultivated their vines more for the purpose of producing the wine necessary for their own consumption than to place it upon the market. In the vine districts the majority of the inhabitants, without distinction of trade or profession, are owners of from six to twelve acres of vines, which are usually cultivated in the same primitive manner as the wine is prepared. During recent years, however, considerable improvement has been manifested in the cultivation of the vine, which it is stated will before long become one of the principal branches of production, and a source of considerable wealth to the country. The vines are situated in close proximity to towns and villages, and within easy distance of railways and canals. The districts of Northern Bulgaria which are most renowned for their wines are the following:—Varna, Schoumla, Roustchouk, Sistova, Plevna, and Widdin; the important wine-producing district in South Bulgaria starts from Slivno towards Tatar-Bazardjik, passing by Tchirpan and Stanimaka. The phylloxera made its first appearance about three years ago, in the vineyard situated near the Servian frontier, in the district of Widdin, about twelve miles from that town, and it appears that the pest was introduced into this region through the medium of plants from the Servian vineyard of Négotine. Immediately on the appearance of the disease, the Bulgarian Government adopted strong measures to stamp it out. The vines which were attacked were uprooted and the holes filled up with lime. The grounds thus disinfected are guarded by watchmen who prevent any person or animal from approaching them. These vineyards, which will remain out of cultivation for three years, are to be replanted with American vines, which will then be grafted upon the native vines. With a view to preventing the spread of the phylloxera, a special law prohiblts the importation into Bulgaria of vines, branches, vine leaves, &c., as well as all tools which may have been used in vine cultivation abroad.

Correspondence.

THE RELIGIONS OF INDIA.

I wish to add a few words to my spoken remarks in support of Sir W. Hunter's admirable paper at the meeting of the Society of Arts, and if I seem to differ from him in some points, it is by way of explanation or modification, rather than criticism.

Christianity and Caste.

In the first place I would venture to point out that the number of Christians in India of all denominations is so small, that any comparison of its increase with that of Hinduism and Islam, must be accepted *cum grano*. It has, moreover, been well observed by Sir William Hunter, that the growth of the various faiths in India is not so much from one another as from the backward races and lowest castes. We must, however, exclude the growth of Hinduism in the Buddhist countries of Ladak, Zanskar, and Lahul, to which I drew attention in 1866, and we must also not forget that Sir Alfred Lyall was among the first to disprove the common notion that Hinduism was not a proselytizing religion. Indeed, even the Sun and Ancestor-worshipping Kafirs of the Hindukush are now feeling Hindu influences. I also found notions of caste prevailing in 1886, which I had not found in various parts of the Himâlayas in 1866 and subsequent years. The full truth, I submit, regarding the progress of Hinduism, may be summed up in the statement that, whilst no conversion of an individual to Hinduism is possible in one sense of the word, as soon as a public opinion can be created for the new convert by the accession of the entire group of families to which he belongs, he can from that moment annex himselt to Hinduism through the formation of an additional caste. If that caste is composed of members of sufficient respectability, there is no reason why it even should not rank high, and there is no doubt that the white Brahminism of the Jesuit missionaries and the Kshatria tendencies of the Nestorian Christians and of the white Jews in Cochin, tended to give them and their faiths an honoured place in Hindu opinion and even polity. Indeed, so great is the tendency to the formation of a caste in the Indian mind that even the native Protestant converts in the south, who have been generally recruited from the lowest or no castes, have shown signs of wishing to be considered as the surviving descendants of the Kshatria race, which Parsu Ram exterminated. Our missionaries, as a rule, not following the larger views expressed by Sir W. Hunter, may be aghast at an evidence of social growth or crystallisation which rather tends to respectability, though it may oppose the notion of all Christians being in every sense equal, a sentiment which is not borne out by facts either here or elsewhere. The Lutheran Caste-Christians are amongst the most respectable Protestant converts we have, and when I asked one of their members at Madura, a centre of Hinduism, how it was that in appearance, strength, and social status the Lutheran Christians seemed to take so much a higher place than the other Christian converts, he replied, "Why it is because our Hindu brethren look after our sons and daughters; they consider our change of faith is a mere matter of the intellect and

the heart, and that as we keep caste, we are their brethren;" in other words, the Lutheran native Christians are not waifs and strays, admitted neither to European nor to Hindu society, but they continue to belong to a branch of respectable native society. In the same way, the Roman Catholics in the South do not make the abandonment of caste a test of the convert's sincerity, and I have known a Roman Catholic bishop decline dining with a Protestant friend, the Collector of the district, because of the effect which his doing so might have on his native Christian congregation. In fact, the progress of Christianity among Hindus would be greater if we confined ourselves to the practice and advocacy of our tenets, and interfered less with social customs; and, further, if we were constructive rather than disruptive, by making, say, the practice of abstinence from intoxicating drinks a distinctive feature of the native Christian caste, and allowed it to grow rather on the basis of the simple Christianity of the Gospel than on the complicated Christianity of England in the nineteenth century.

To sum up, caste is the cement by which Hindu society is kept together, and just as no respectable Englishman of whatever class repudiates "gentlemanly" feeling, so no Hindu, who is not an outcaste himself, will depreciate caste, although, like every other human institution, it has its imperfections.

Christianity and Muhammadanism.

As for Muhammadanism, it has always been a subject of regret and astonishment to me that the sister faith of Christianity has been so unsisterly to it. There is so much in which we can agree with Muhammedans, that it would have been wise, not to say truly Christian, to lay greater stress in our relation with them on the points in which we agree than on those in which we differ. This does not in the least imply that we are to be less Christian in our doctrine, and, above all, conduct, but that we shall not seek occasions for bitter dissensions, dangerous alike to our political and religious influence, which dissensions are generally based on misconceptions or half-knowledge, whereas we and the Muhammadans should go hand-in-hand politically, socially, and as fellow-labourers on those fields in which the conversion of backward races to any religion is better than their present condition.

Insufficient Employment of Muhammadans.

I do not think that the rights of the Muhammadans of the North-West and Oudh to employment under our Government are at all met by having 34 per cent. of the administrative offices, because although they may only be $13\frac{1}{2}$ per cent. of the population, they belong to a class which has the tradition and hereditary capacity of rule. Nor is it a fact that the drawbacks, if any, to the more numerous employment of Muhammadans arise from the too exclusively religious character of the Muhammadan primary schools. I have studied myself in a Mosque school, and I find that the instruction given is secular, so far as reading and writing are concerned; that it is moral, if we have regard to the books of conduct that are read and to the discipline and organisation of these schools; and that it is religious, so far as the teaching of the Koran is concerned, and so far as everything Oriental, if it is at all real, must have a religious basis. If the Hindus occupy the remaining 64 per cent. of appointments, it is not solely because of their larger numbers, but because it is not the same class of Hindus that competes with the equivalent class of Muhammadans, even if we include in our comparison the Hindu Kayasthas, or writer class. What Sir William Hunter says is, "the one object of th young Hindu (apart from his home religious training) is to get such an education as will fit him for success in life; but this class of Hindu has little, if any, religious training." If this be so, then the Hindu in question does not belong to the higher professional or ruling classes. Indeed, just as scholastic theology would be unsuitable to an ordinary English student, so the Vedas are withheld from the common Hindu, and it is distinctly laid down that a member, *e.g.*, of the mercantile class can only become virtuous *after* he has succeeded in his business; although, if he *will* study the Hindu sacred texts, and practise the austerities and ceremonies without which caste progress is impossible, he may rise to be the equal of gods. Well, then, on the one hand you have Muhammadan students, belonging, as a rule, to the ruling and professional classes, holding only 34 per cent. of the appointments; whilst, on the other, the 64 per cent. of the Hindus do not, as a rule, belong to their own professional or ruling classes, so that a comparison between the two communities is not complete without this explanation. Further, I hold that India can only be properly governed by European, Muhammadan, and Hindu gentlemen by birth.

The Grandeur of Hinduism

Sir William Hunter's definition of Hinduism is admirable, but I would add that lofty as its monotheism is for its philosophers, its polytheism is an unexplored mine of historical and scientific truths, which yet awaits the impartial labour on a scarcely trodden field. Even for the masses there is no idolatry in one sense of the term. Every idol, indeed, is, by its very grotesqueness or peculiarity, a proof that the divine can *not* be represented except symbolically or conventionally; not that, as we think, it *is* so represented by the Hindus. It is the sacrificial dedication that makes the so-called idol an object of worship, and I have not yet found the Hindu who looked upon the stone or figure as the very God Himself, just as little as I have found a Roman Catholic who looked upon a painting or sculpture of

Christ on the Cross as the very Christ who was crucified 1800 and odd years ago.

I remember asking, before I had studied the subject of Indian idolatry, a woman whom I saw worshipping a most hideously-coloured triangular stone, roughly carved into a semblance of Ganesh (this was in a village in the Central Provinces, behind a mud hut), "Why do you worship this?" "Because," she said, "whenever I pass it my heart is raised, especially since I have had a son." It seemed to me that there was more tenderness and piety in this remark than we generally attribute to the worshipper of stocks and stones. So far from the religions and civilisation of India having been exhaustively treated by any of the writers or speakers on the subject, these great Himâlayas of Indian culture have scarcely, as yet, been scratched by a quill.

I was not aware that the appeal to the Vedas to cross the black waters without loss of caste had been successfully made. I have attempted it with Pandits at Benares and elsewhere, and they have collected texts which would show the crossing of the black waters to be a venial offence, or to be undertaken only in the pursuit of learning, or under an inevitable necessity, but the opinions on the subject are still much divided, and until a consensus has been obtained, very few, if any, respectable Hindus will care to visit England.

As regards infant marriage (the great protective against immorality), and widow re-marrriage, which is quite common among castes that do not aspire at following the fashion of the highest castes, there is much more to be said than is possible at present. Suffice it to point out that the most extraordinary misconceptions prevail on this subject among so-called reformers, both in England and India.

Missionary Enterprise.

In conclusion, I would endorse what Sir William Hnnter said, "as an Englishman," because I believe that if the instinct for colonial expansion and Imperial rule is sanctified by missionary enterprise, in the noblest sense of the word, it will be guided to better results than the repression of native industries, the destruction of native society, and the spiritual subordination of those from whom their temporalities have been taken, than which no conquest can be more complete, or, I may add, more suicidal to the victor. If missionary enterprise evokes the national spirit of those whom it converts, and if it safeguards indigenous culture, a Christian Church may yet arise in India that may fitly send missionaries to England. In the meanwhile, let us learn from Hinduism, Buddhism, and Muhammadanism, those truths which will foster our own spiritual growth, enlarge our knowledge and understanding of the Divine, and cultivate those Christian graces—that Charity which is the first of all virtues.

G. W. Leitner.

Oriental Institute, Woking.

UNIFORMITY IN SHORTHAND.

A paragraph recently appeared in the *Pall Mall Gazette* stating, that memorials to the Society of Arts and the Universities against any particular system of shorthand being specified in the syllabus of the examination for the new Commercial Certificate, had been signed by so many Parliamentary reporters. The paragraph stated what systems of shorthand were written by those who had signed the memorials, and the figures showed that the writers of Pitman's shorthand were in vast preponderance over the writers of other systems. There were some, including myself, who declined to sign the memorials; and there were some who signed them without much reflection to oblige the amiable gentleman by whom they were presented. Those who have declined have no right to object to their friends expressing their opinions, but there is a danger that the memorials may do harm by producing the impression that the diversity of systems used in the Gallery and for newspaper work may be permitted and even encouraged in the extended use of shorthand for commercial purposes. Such an impression is likely to operate to the prejudice of some who allow themselves to be influenced by it, to the extent of chosing a system of shorthand used by a small minority of shorthand writers.

The question concerns the community as well as individual shorthand writers. The public has far more to gain from uniformity than from diversity. It is no part of the purpose for which shorthand is being introduced into commercial examinations to produce newspaper reporters or professional shorthand writers. These are, or ought to be, experts, made such by special training. It would be with them a matter of business to avail themselves of any great change worthy of their attention. The fallacy which underlies the Gallery memorial is this, that because newspaper reporters transcribe their own notes, and therefore nobody need read them but themselves, the future use of shorthand, for all purposes, is to be subject to the same limitation. This would mean that, for commercial purposes, no use was to be made of shorthand, except by dictation to amanuenses, who must transcribe their notes into longhand before any use can be made of them. There is not the least necessity for any such restriction, and it will not be submitted to by business men. To give even indirect encouragement to such a restriction is to put a premium on inefficiency. For a long time past experts have taken *verbatim* notes of Parliamentary committees and commissions with such proficiency that the notes have been accurately transcribed by clerks who were not present when the notes were taken. This has been done in two systems—and, I believe, in two only. These are Gurney's and Pitman's, of which only the second has been popularised. What is done by trained experts, under circumstances of great pressure and reponsibility, can be done with great ease, under less

pressure, in business and in private life. Books can be kept, memoranda made, drafts of documents and correspondence written in shorthand, so that all who have learned the rudiments of the same system can easily refer to them and read them. But all the convenience and despatch resulting from this possibility is sacrificed if several systems of shorthand are used in one establishment. Principals are concerned quite as much as clerks. There is now a shorthand class at Rugby. Suppose a Rugby boy becomes a City magnate. In his leisure he makes memoranda or writes the draft of a speech on paper in his own shorthand. Coming to the office he says to a clerk, "Copy that." The clerk says, "Please, sir, I don't write your system of shorthand; will you read it to me?" And so the employer has to lose a part of the time he thought he had saved by dictating what he had written. All this vexation and loss of time are quite needless. There is a vast amount of correspondence with agents and representatives that can be carried on just as well in shorthand as in longhand.

These considerations go to show that the world has much to gain from the general adoption of one system, and much to lose from the multiplication of systems. It does not follow that examining bodies should select the system most suitable for general use, but their not doing so ought not to be used as an argument for diversity as opposed to uniformity. It may be a question how far you are justified in confining examination in shorthand to a result test which assumes that the written characters, whatever the system, are not to be looked at. It would certainly be better if the examiners could look at the shorthand notes, and be guided by them as well as by the transcript. This could be more practicable if one system were generally adopted. It would certainly produce more careful writers. There are amanuenses to whom exactness in shorthand and advance in the adoption of special forms are of more importance than they are to general reporters; but yet these shorthand writers could not do the work of the reporters, and the reporters would not easily adapt themselves to the work of the amanuenses. What commercial men want is, not the general intelligence of the reporter who uses shorthand as an auxiliary, but verbal precision in matters of business. And this precision, in a general shorthand system, will greatly expedite indoor business. As it came to be understood that one system of shorthand was in common use, houses would venture to conduct portions of their correspondence in shorthand, and this would greatly facilitate correspondence and business transactions. A very little experience in these respects will soon settle the question of systems, by putting uniformity above every other consideration.

Meanwhile, newspapers, which ought to take the lead, are lagging behind. The greatest waste of time and energy in the civilised world is involved in the writing of "copy" for newspapers. There is no reason why printers should not be trained to read elementary shorthand—and reading is a very different thing from writing. A great part of the copy could then be prepared in shorthand. This would save certainly more than half of the time occupied in writing bad longhand (to put the saving at a minimum which no one can question); and the saving of time would often be a very great advantage in avoiding pressure in the printing office, and the risk of not getting to press at the proper moment. In this matter newspapers ought to be pioneers, but their conservatism is amazing. Instead of guiding the commercial world, they will follow it, and next century the historian will record with astonishment that even in the closing years of Victoria's reign, newspaper "copy" was written in longhand, although it was well known that more than half the labour and time required to so write it might easily have been saved.

Having used shorthand for more than 30 years, and for nearly a quarter of a century in the Gallery, I desire to see in the general adoption of shorthand for business purposes, the avoidance of that diversity which will involve inconvenience to employers and disappointment to individuals. These disadvantages will far outweigh any possible advantages from future improvements. If any real improvements are made they will be tested by professional experts long before others need trouble about them. English-speaking peoples have most to gain by utilising at once the system which is developed for all purposes to a very high point, and the mere rudiments of which will serve for correspondence between all who have mastered very little more than the alphabet.

WILLIAM STORR.

3, Lambert-road, Brixton-rise,
March, 17, 1888.

[*** Candidates are allowed to use any system they please in the Society's examinations. Those beginning the study of shorthand are recommended to adopt phonography, but the writers of any other system are equally eligible for examination.—ED. *S. of A. Journal.*]

CANAL IRRIGATION IN INDIA.

Mr. J. F. HEWITT writes respecting his remarks in the discussion on Mr. Thornton's paper (see *ante*, p. 519), that what he meant to say about the railway to the coalfields was—"The line from Benares to Gya, passing through the most northerly coalfield, has been surveyed, and could be constructed for a little under two millions." Further, the statement respecting the price of firewood in Gya should stand as "about eighteen shillings or nine rupees per ton."

Sir OWEN BURNE, K.C.S.I., writes to correct the statement in his remarks, printed on p. 522, col. 1. He said, "The Ganges Canal, upper and lower,

was something like 900 miles long, with &c. . . . and the Eastern and Western Jumna Canals, taken together, were about 600 miles long, with " &c.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 11.—"Recent Legislature concerning the Pollution of Air or Water." By ALFRED E. FLETCHER, Chief Inspector of Alkali, &c., Works. Professor Sir HENRY E. ROSCOE, M.P., F.R.S., will preside.

APRIL 18.—"Telescopes for Stellar Photography." By Sir HOWARD GRUBB, F.R.S.

APRIL 25.—"The Physical Culture of Women." By Miss CHREIMAN.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

APRIL 17.—"A Hundred Years' Progress in New South Wales." By W. F. BUCHANAN.

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

APRIL 24.—"Craftsman and Manufacturer." By LEWIS FOREMAN DAY. JOHN SPARKES, Principal of the National Art Training School, will preside.

MAY 8.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

MAY 29.—"Persian Textiles." By CECIL SMITH.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras. Sir JAMES CAIRD, K.C.B., will preside.

MAY 4.—"Caste." By Dr. G. W. Leitner.

The above dates are liable to alteration.

CANTOR LECTURES.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

LECTURE I.—APRIL 9.—Our Milk Supply.—Changes in town supply from various causes.—Agricultural depression, its effect in improving breed of cattle, and their food for milk production.—An agricultural department wanted to impart knowledge, to direct inquiry, and to stimulate practical education in dairy farming.—Milk not of uniform composition although containing the same constituents; a perfect food; compensation of different kinds of milk; how preserved for ordinary use; cooling, its effect; why milk becomes sour.—Methods of milk examination; in the dairy, the depôt, and the laboratory.

LECTURE II.—APRIL 16.—Our Butter Supply.—Changes, as shown by imports and exports.—Butter imported in fresh or salt condition, according to position of country of production.—Home producer at a disadvantage; why?—Co-operation necessary; its working.—Letting cows, creameries, lump butter.—Central factories.—Milk for butter making; its treatment.—Sour and sweet cream.—Setting milk in shallow and deep pans.—The Schwartz, Cooley, and other systems.—Cream separators, centrifugal machines, De Laval's separator.—Churning, how done.—Different ways of making up butter for market.—The Danish, Swedish, Dutch, French, and Irish methods.—Improvement in English methods.—Butter substitutes.—Margarine (butterine), how made.—Legislation.—Butter, its composition; its adulteration and methods of detection.

LECTURE III.—APRIL 23.—Our Cheese Supply.—Increased imports.—Best milk for cheesemaking.—Coagulation of milk, treatment of the curd, ripening.—Home-made cheese, Cheddar, Gloucester, Cheshire, Derbyshire, North Wilts, and Stilton.—Foreign-made cheese, American, Dutch.—Fancy cheese, cream, Gruyere, Gorgonzola, Roquefort.

MEETINGS FOR THE ENSUING WEEK.

WEDNESDAY, APRIL 4...Entomological, 11, Chandos street, W., 7 p.m. 1. Mr. Martin Jacoby, "Description of new or little known species of Phytophagous *Coleoptera* from Africa and Madagascar." 2. Exhibition of a Collection of Insects lately received from Baron Ferdinand von Mueller, and obtained by Mr. Sayer during the recent expedition to New Guinea, under the direction of the Royal Geographical Society of Australia.

THURSDAY, APRIL 5...Chemical, Burlington-house, W., 8 p.m. Prof. R. Meldola and Mr. F. J. East, "Researches on the Constitution of Azo and Diazo Derivatives III. Compounds of the Naphthaline B Series."

FRIDAY, APRIL 6...Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. McMurtrie, "Coke Making."

Geologists' Association, University College, W.C., 8 p.m. 1. Mr. J. Bennett, of H.M. Geological Survey, "The Influence of Geology on the Early Settlements and Roads." 2. J. Allen Brown, "The Discovery of *Elephas primigenius* associated with Flint Elements, at Southall."

Philological, University College, W.C., 8 p.m. Mr. E. L. Brandreth, "A Sub-Editor's Work for the Society's Dictionary."

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FRIDAY, APRIL 6, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

Committee.—Sir Douglas Galton, K.C.B., F.R.S. (Chairman of the Council), Sir Frederick Bramwell, D.C.L., F.R.S., W. H. Barlow, F.R.S., E. C. Robins, F.S.A., Col. A. E. Hamilton, R.E.

A conference will be held on this subject, by the Society of Arts, on Thursday, Friday, and Saturday, May 10th, 11th, and 12th, 1888. The following, amongst others, are subjects on which suitable papers will be received:—

1. History of the rise and progress of canal and inland river navigation in Great Britain and Ireland.

2. Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c.

3. The canals of other countries.

4. Present condition of canal navigation in Great Britain and Ireland. Suggestions for its improvement.

5. Canals and railways—their mutual influence on each other.

6. Comparative cost of transport by railways and by canals. Tariffs.

7. The law of canals, and matters relating thereto.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 27, 1888; Hyde Clarke in the chair.

The paper read was—

THE PANAMA CANAL AND ITS RIVALS.

By J. Stephen Jeans.

Three hundred years ago, the enterprise of cutting a navigable highway between the Atlantic and the Pacific oceans was exciting the attention of the then civilised world, as it has frequently done since, and continues to do in our own day. There is, perhaps, no project that can be imagined which, on the face of it, has a greater claim to the support and admiration of mankind. And yet, as we all know, the enterprise is still incomplete, although it has been carried a long way towards completion in the case of the Panama Canal. The serious difficulties, both engineering and financial, that have beset the latter undertaking, the zeal and energy with which rival projects for the construction of a ship-canal across the State of Nicaragua are being promoted by two American companies, the colossal character of the enterprise, and the magnificent results which its ultimate consummation is likely to produce on the world's commerce, have suggested to the Council of the Society that an evening's consideration may suitably and profitably be devoted to the whole subject.

There are three aspects under which the proposals to construct a ship-canal across the American isthmus may be regarded. The historical, the engineering or constructive, and the commercial. The political side of the question is not less important, but is not, perhaps, so engrossing at the present time. It is difficult to say which of these aspects is the most interesting. It is certain that, in the course of an hour's lecture, justice cannot be done to them all.

Historical.

If we would learn the early history of the various schemes for constructing a water-way across the American isthmus, we must make ourselves familiar with the operations of the conqueror, Cortez, who, after his conquest of Mexico, in 1519, spent some considerable time on the isthmus, and who, in his letters to Charles V., declared that the discovery of a natural strait between the two oceans, which he appears to have reckoned on finding, was "the one thing above all others in the world I am most desirous of meeting with, on account of the immense utility which, I am convinced, would result from it."

Until the commencement of the present century such an enterprise as the joining

together of the two oceans by a canal, adapted for ship navigation, would hardly be accepted as possible. The idea, however, as we have already indicated, was by no means a new one three hundred years ago. In 1588, an old Spanish historian, P. Acosta, wrote that, in his opinion, "No human power would be sufficient to cut through the strong and impenetrable bounds which God has put between the two oceans, of mountains and iron rocks, which can stand the fury of the raging seas." And then follows a reflection common to those times, and equally applied to many engineering works of modern times, that "If it were possible it would appear to me to be very just to fear the vengeance of heaven for attempting to improve the works which the Creator, in his Almighty will and providence, ordered from the creation of the world." Notwithstanding the prevalence of views like these, in days when engineering triumphs were almost unknown, the project of connecting the two oceans was frequently revived. William Paterson took a keen interest in the matters in connection with his Darien enterprise, the history of which will always be associated with the American isthmus and its fortunes, although Paterson did not regard the formation of a ship-canal as one of his more immediate aims. In his memorial to the king, in 1701, that remarkable man discussed the various passes across the isthmus, and gave a preference to the Chagres route, the same by which the Panama Canal is now being carried. The distance across the isthmus at this point was stated by Paterson to be eight short French leagues, and he declared his belief that for a distance of six leagues a canal might easily be cut through. The other two passages, however, he held to be very difficult, referring, probably, to the passage of the Culebra Col, of which we shall have more to say by and by.

The knowledge that was possessed of the interior of the isthmus up to the beginning of the present century was very meagre, but, in 1799, Humboldt, having received permission from the Spanish Government to visit and explore its dominions in America, repaired previous deficiencies to a large extent by his interesting "Tableau Physique des Regions Equatoriales," in which he enumerates no fewer than nine different points at which the two oceans might be connected. These were—

1. In the parallel of Queen Charlotte's Island, about the 54° of North Latitude, ascending the Columbia to its source, then crossing the Stony mountains and following the course of the Dumgigah to Slave Lake; thence by Mackenzie's River to Hudson's Bay.

2. In the Latitude of 40° by the Rio del Norte to the Gulf of Mexico.

3. By the Isthmus of Techuantepec, in 16° latitude, by cutting a canal to connect the head of the Huasacualco, which runs into the Gulf of Mexico, with that of the Rio de Chamalapa, which falls into the Pacific.

4. By the San Juan River and Lake of Nicaragua—the same route as is now proposed by two American companies.

5. By the Isthmus of Panama, and the navigation of the Rio Chagres. This is really M. de Lesseps' scheme, but Humboldt regarded the navigation of the Chagres River as very difficult and hazardous, and he inclined to think that the project could be affected only on a small scale, and by means of a system of locks and tunnels.

6. By opening up a canal, 20 miles in length, from the Bight of Cupica, near Cape Corientes, to the navigable stream of Naipi, and thence *viâ* the Atrato river, which falls into the Gulf of Darien.

7. By the Raspadura, which connects the San Juan River with the Quito, one of the branches of the Atrato.

8. By constructing a road from the city of Lima across the chain of the Andes to the River Gualloga, which falls into the Maragnon. Humboldt's idea was, that by this route, goods could be conveyed from the coast of Peru to the shores of Brazil.

9. By the Forth of Aysen, on the west side of the continent, which penetrates far into the interior, and thence by a small river.

In 1788, a passage between the two oceans for small craft was actually accomplished. The author of this achievement was the curate of Novita, who induced his Indian flock to cut a trench between the upper streams of the San Juan River, near Chirambira Bay, and the higher waters of the River Atrato, which flow into the Atlantic through Choco Bay, in the Gulf of Darien, so that they could pass from the Caribbean to the Pacific in their canoes. In carrying this passage into effect, the Arastradera, or summit level, a plain about three miles in width, formed by an interruption of the mountainous ridge, was cut across. The passage was, however, dangerous and difficult at all times, even for canoes, and the communication has now for many years been neglected and disused.

In 1827, an officer of Engineers in the Colombian service, Captain Lloyd, made a special survey of the Isthmus of Darien, in order to ascertain the best and most eligible line of communication between the two seas, whether by road or canal. A very interesting

account of this expedition is contained in the archives of the Royal and the Royal Geographical Societies.

In 1838, the Franco-Grenadine Company obtained from the Government of New Grenada a concession for the construction of a canal across the Isthmus of Panama. The Company appears to have looked to the French Government to give them some assistance in the carrying out of their enterprise. They made it their business, at any rate at an early stage of their proceedings, to submit to the French Cabinet a report on the result of their inquiries as to the prospects of such an undertaking, and induced the Government to appoint an engineer to investigate the merits of their scheme. The Franco-Grenadine Company did not, however, commence their proposed works within the time specified in their concession, which consequently lapsed.

In 1843, M. Guizot, then Minister for Foreign Affairs in France, issued a commission to M. Napoleon Garella, Chief Engineer of Mines, to "go to Panama, with directions to inquire and examine into the question relative to the two seas by cutting across the isthmus, and to seek a practical solution, not only with respect to the practicability of making a canal, and the nature of the obstacles to be surmounted, but also as to the means requisite to ensure success, and the expenses which such an enterprise would involve." Having executed this commission—as some say, very imperfectly—M. Garella calculated that the cost of a canal across the isthmus, to admit of the passage of vessels of 1,200 tons, would be 125 millions of francs, or five millions sterling! The plans submitted by M. Garella, and which he proposed to carry out for this sum, provided for locks 46 ft. 6 in. wide, and a distance of 218 ft. between the aprons. The depth of water was to be 23 ft., or 20 inches more than the draught of water of the largest vessel that the locks would admit. A canal of smaller size, to admit vessels of 600 tons, was estimated to cost about £3,600,000, or about one-thirty-fourth part of the present maximum estimated cost of the canal of M. de Lesseps. M. Garella urged the Government of France to initiate a movement for the construction of the canal, but without success.

England has made some, but not very many, nor very important, contributions to the history of the Panama Canal. In 1840, the directors of the Pacific Steam Navigation Company commissioned Mr. William Wheelwright to examine the capabilities of the River Chagres, and the best means of communication with the South Sea (Pacific). He reported that the depth of the Chagres bar was 12½ feet, that a road could be made to transport passengers in about five or six hours from the steamers of the Pacific to those of the Atlantic, while loaded mules could traverse it in ten or twelve hours; that steamers of 600 or 700 tons burthen might enter and ascend the River Chagres to its junction with the River Trinidad at all times and seasons; but that the Trinidad river was shallow, and only available for very small craft. No action was taken upon the report. The directors of the Pacific Steam Navigation Company had evidently made up their minds that it did not hold out any prospect of their being able to make use of the rivers that traverse the isthmus for navigable purposes.

One of the most notable and historically interesting facts connected with the Panama project is, that the very scheme which has been the pet of M. de Lesseps, and which he has carried so far towards completion, was emphatically condemned by his former Emperor. Speaking in 1849, at the Institution of Civil Engineers, Prince (afterwards Emperor) Napoleon strongly recommended the Nicaraguan in preference to the Panama route. He stated that whereas a canal across the Isthmus of Panama would traverse a country "which was marshy, unwholesome, desolate, and uninhabitable, which would afford a passage of but 30 miles, amidst stagnant waters and barren rocks, yielding no spot of ground fitted for the growth of a trading community, for sheltering fleets, or for the development and interchange of the produce of the soil, a canal across the Isthmus of Nicaragua, having its course from San Juan to Realejo, would avail itself of the River San Juan, which received a great many small streams, besides three larger ones, that were navigable for boats to a considerable distance inland; it would run in a straight line about 278 miles, enhancing the prosperity on either bank of more than a thousand miles of territory, taking into account the sinuosities of the lakes and the course of the internal rivers;" and "the effect that would be produced by the annual passage through this fine country of two or three thousand ships, exchanging foreign produce with that of Central America, and spreading everywhere activity and wealth, would be almost miraculous." Seven years previous to this occasion

several influential persons in Central America wrote to Napoleon when he was a prisoner in the fortress of Ham, proposing that he should endeavour to obtain his freedom under a pledge to proceed to Central America and construct a canal through the State of Nicaragua, and in 1845 this overture was renewed by the Nicaraguan Government. But the French Government refused to liberate the Prince, and when a few months later he escaped to England, he did not seem inclined to accept the offer, although he wrote a pamphlet on the subject, in which he estimated the cost of a canal for vessels of 300 tons, *viâ* the Lake of Nicaragua, at four millions sterling!

Coming down to more modern times, we find that it has been the practice of even the best-informed writers to pooh-pooh and decry the proposed canal. In 1863, a writer in the *Quarterly Review* wrote that the railway constructed across the isthmus would "answer the purposes of all the traffic we can now foresee, at a far less expense, and with far more certainty and rapidity than a ship-canal, even supposing that a ship-canal could be constructed at the same expense as the Suez Folly. The science and skill of modern engineers could, no doubt, conquer the difficulties of this route as easily as that of Suez, if it were worth while, but is probable that the one would be of as little advantage to commerce as the other, and it therefore will hardly be attempted!" Twenty years later, when the construction of the Panama Canal had actually been begun, another writer in the *Edinburgh Review* declared that "those persons must have an extraordinary amount of confidence in the value of *châteaux en espagne* who can conclude that any individual connected with the direction (of the canal) at this moment entertains any serious idea that the physical execution of the canal is a matter within the range of either practical engineering or practical finance."

It is scarcely necessary to detail the circumstances that led to the formation of the present Panama Canal Company in 1879, under the auspices and guidance of M. de Lesseps. It is, however, interesting to know that neither that distinguished engineer, nor M. Garella, was the first Frenchman to plant his foot on the isthmus with that purpose in view. More than two and a-half centuries ago, Samuel de Champlain, after fighting in the Wars of the League, founding the colony of "New France," and giving his name to Lake Champlain, journeyed through the West Indies and Mexico, and eventually arrived at Panama, where he conceived the plan of a ship-canal across the isthmus, "by which," he says, "the voyage to the South Seas would be shortened by more than 1,500 leagues." We have already seen that M. Guizot, when Minister of Foreign Affairs, had a similar purpose in view, and actually issued a commission for the survey of the isthmus. But to M. de Lesseps belongs the credit, if credit it be, of having put into actual practice an enterprise that had long excited the hopes, and stirred the imagination of his own countrymen without yielding any more definite result.

Physical and Engineering Aspects.

As originally planned, the length of the Panama Canal was estimated at 46½ miles, and it was intended to follow the course of the valley of the Chagres. Starting with sea level at Colon, on the Atlantic, the land for the first ten miles of the course of the canal is comparatively level, but it gradually reaches an elevation of 20 feet at Dos Hermands. In the next ten miles, to Frijole, it attains an average elevation of 40 feet, but a hill of 170 feet high is encountered for a short distance at Bohio Soldado. In the next seven miles, from Frijole to Mamei, the elevation varies from 50 to 120 feet, and from Mamei to Matachin, the canal has to pass for about three miles through a hill 170 feet above tide water. Between Matachin and Culebra, a further distance of seven miles, the canal has to be cut through a series of hills, varying from 100 to 250 feet in height, and at Culebra, the highest summit on the line of route, the elevation above sea level for some hundreds of yards is above 322 feet. Culebra is about 34 miles from Colon, and about 12 miles from Panama, and from this point the land rapidly falls towards the Pacific, there being, indeed, a decline of nearly 300 feet in a distance of three miles. At Rio Grande, where the elevation is 30 feet above ocean level, the land falls still further, until at La Boca, eight miles from Culebra, and four miles from Panama, ocean level is attained, and it is expected that for this last section of the route, the canal will have to be dredged into the Bay of Panama.

The engineering difficulties to be met are exceptionally formidable; first, because it is necessary to control the waters of the River Chagres, which, in the rainy season—usually lasting for eight months out of the twelve—would be liable to flood the greater part of the canal every year; and next, because the cut through

the Andes at Culebra would be the most serious and extensive piece of excavation that has ever been undertaken in the history of engineering science. A third difficulty, but a less formidable one than either of the other two, is the dredging of the last four miles of the canal, so as to keep it free from the material silted up by the ocean, and brought down by the Rio Grande.

In order to appreciate the vast importance of the first of these difficulties, it is necessary to bear in mind that the Chagres river, which springs from the western slope of the range of hills that look down on the Caribbean Sea from the Gulf of San Blas, drains an area, estimated at 1,550 English square miles, over which there is a rainfall of at least 120 inches annually. In the wet season, this river has been known to rise from forty to fifty feet above its normal level, and the flood volume of the rivers has been estimated by some at 67,000 to 70,000 cubic feet per second, and by others at 1,600 metric tons of water per second, which is four times the volume of the highest flood ever measured on the Thames. In order to control this vast and torrential body of water, two plans have been proposed—the first to construct a great dam across the head waters of the Chagres, at Gamboa, which shall be large and strong enough to hold all the water that may fall, over and above what can be carried away safely by the ordinary channel of the river; and the second, to dispense with the dam and enlarge the derivative channels sufficiently to carry off the greatest volume of water by which the Chagres is liable to be swollen. Either alternative must involve enormous cost, and the exercise of high engineering skill. The Gamboa dam is the one that has ultimately been determined on, and the latest dimensions fixed for that undertaking are:—3,970 feet in length, 1,422 feet in width, 149 feet in height. Behind this dam it is estimated that there will be about ten millions of cubic feet of water banked up. The flanks of this huge dam will rest on two hills, called severally the Cerro Obispo and the Cerro Santa Cruz, which it is proposed to tunnel; and through these tunnels the water, which would otherwise follow the course of the canal, will flow to another watershed, and thence to the sea.

It was estimated some years ago by a commission of the Academy of Sciences that the Culebra cut would involve thirty-seven millions of cubic yards of excavation. A more recent report, made to the New York Chamber of Commerce, calculates the excavation necessary at twenty-two millions of cubic yards. It is difficult to realise the magnitude of either sum. The first estimate has been calculated at some twenty times the bulk of the great pyramid, and the whole of the excavation must be done within a distance of less than a mile and a half. It is estimated by the agent of the Columbian Government, that "at least 15,000,000 metres (of this excavation) must be transported about eighteen kilometres and thrown into Panama Bay, as the valley of Paraiso will be filled when 8,000,000 metres shall have been thrown there, and the same will be true of Emperador and Obispo." The contract for this cutting was let to an Anglo-Dutch Company, who bound themselves to remove 700,000 metres a month. At this rate the work would have been completed within three years. There have, however, been hitherto insurmountable difficulties in the way of carrying out this programme, and it is stated that not more than 100,000 cubic metres have been removed in any one month.

The original plans of the Panama Canal provided for a water-way that should be 28 feet below the mean ocean level throughout its entire length. It has since been found that this design would involve an enormous expenditure and a serious delay, and hence it has been decided to provide a series of four locks on the Pacific, and four locks on the Atlantic side. On the Atlantic side, two of the locks will have a fall of 8 metres (26 ft. 5 in.), and two will have a fall of 11 metres each (36 ft. 3 in.), while on the Pacific side, three locks will have a fall of 11 metres each (36 ft. 3 in.), and one will have a fall of 8 metres (26 ft. 5 in.). The height of the water level, on the Pacific side, will therefore be 41 metres (135·6 ft.), and on the Atlantic side it will be 38 metres (125·7 ft.). The width of the lock gates will be 18 metres (59·5 ft.), and the length will be 180 metres (595·5 ft.). The locks and their gates will be constructed in iron, and it is estimated that 20,000 tons of cast, and 15,000 tons of wrought iron will be employed in their construction. The effect of this modification of the original plans will be to reduce the amount of excavation necessary in the Culebra cut by at least one-third, but it will obviously alter the entire character of the canal as first projected.

The arrangements necessary for the dredging of the bed of the canal between La Boca, at the mouth of the Rio Grande, and Panama Bay, are not by any means child's play. It is expected that a dyke will ultimately have to

be run from Gama Point, near to Nases Island, some four miles across, to keep the sand from washing into the canal, and that a temporary dam will have to be built across the Rio Grande, to keep the water high enough to float the dredges at low tide. This work will, moreover, require to be done in the midst of the pestilential exhalations of the mangrove swamps through which the Rio Grande finds its way to the sea, and the insalubrity of the climate is likely to prove in the future, as it has proved hitherto, a serious obstacle in the way of obtaining the necessary supplies of labour, notwithstanding that, as Mr. Bigelow remarks, "human life is about the cheapest article to be purchased on the isthmus." *

The rate of progress made with the canal up to the present time has been much inferior to what was originally contemplated. Senor Armero states that on the 1st September last, of the total estimated quantity of 161 millions of cubic metres, only about 34 millions, or 21 per cent. of the required excavation, had been done. The remaining four-fifths, he calculated, would be much more troublesome and expensive, as being nearer the water-level. Much will, of course, depend upon the extent to which labour-saving machinery can be utilised in the undertaking; but it may be remarked, as a signal example of the uncertainty that generally environs the enterprise, that, while M. de Lesseps speaks of having the canal opened in 1889, a recent writer in the *Edinburgh Review* estimates that the human labour requisite to perform the excavation necessary, would occupy 20,000 men for 42 years, making no allowance for *épuisement*.

The Commercial Aspects of the Panama Canal.

The magnitude of the works necessary to the carrying out of the Panama Canal project necessarily demands a vast expenditure. What that expenditure is to be no one appears to be in a position to say. The original capital of the Company was £12,000,000 sterling, which, however, was ridiculously inadequate. In 1879, M. Ribourt, one of the engineers of the St. Gothard Tunnel, estimated that without buildings, houses for the workmen, or hospitals, the canal would cost £37,000,000; and a little later still, M. Voisin Bey, reporting for the second sub-commission, placed the probable outlay at the still higher figure of £42,000,000, and the period necessary to complete the work at a dozen years. All these calculations are very wide of the actual mark. Up to September last £33,000,000 had actually been spent on the enterprise, and Senor Armero, in a report, dated last October, which he presented to the Colombian Government, through whose territory the canal passes, estimated that £120,000,000 more would be required to complete it. It is needless to say that M. de Lesseps and his friends do not endorse this estimate, which is probably an outside and possibly an exaggerated one; but M. Armero gives reasons for his statement, and declares that the work of controlling the waters of the Chagres alone, which at the date of his report had hardly been begun, would cost some £19,000,000 or £20,000,000. The total amount of capital provided for the enterprise up to the beginning of February was about £40,000,000. A further loan of £14,000,000 was to be raised by resolution of the Company, adopted on the 1st March last. But it is evident that this is still a long way from assuring the completion of the enterprise, and it is perhaps hardly surprising, in view of the vast natural obstacles to be overcome, and the almost appalling expenditure involved, that a recent writer speaks of it as "rather worthy to adorn the name of Alexandre Dumas, or the author of the tales of the 'Arabian Nights,' than that of any person familiar with the practical execution of public works." * On the other hand, there are not a few who seem to think that France is already too deeply committed to the enterprise to see it abandoned, and that *amour propre* on the part of the 120,000 stockholders, and the French nation generally, will lead to its ultimate completion. This, however, must necessarily depend largely upon the prospects of the undertaking as a dividend-paying concern. The highest estimate of the tonnage likely to use the canal—that of the *Capitaliste* of Paris—puts it at 10,000,000 tons a-year. M. Levasseur, a high authority, reduces this to 7,000,000, and M. de Lesseps himself is credited with an estimate of 6,000,000, while Dr. Long, the American Consul at Panama, puts the figure at only 3,000,000 tons. Now, even if we take the highest figure hitherto put forward, and assume an average of 10s. per ton—that being approximately the Suez Canal rate—the total gross income would only be £5,000,000 sterling per annum. From this gross income, the working expenses—which in the case of the Suez Canal amount

* Report to the New York Chamber of Commerce, May, 1886.

* *Edinburgh Review*, April, 1882.

to 10 per cent. of the gross earnings, including administration, transit, navigation, and water-supply, would have to be deducted. But even if we assumed that the Panama Canal would only require one-fifth of the gross income for working expenses, and that that gross income is taken at the highest figure at which I have anywhere seen it stated, the balance available for dividend would not exceed £4,000,000 sterling, a sum that would pay only 2·6 per cent. on the latest estimate of the capital required, made by an apparently disinterested authority.* The prospects of the shareholders, on this showing, can hardly be considered cheerful, nor is it surprising to find that the future of the enterprise is jeopardised on financial grounds. Under these circumstances, the attention of the world is likely to be more firmly fixed upon the only rival scheme that is seriously mooted—that of a water-way across the State of Nicaragua.

The Nicaraguan Canal.

At the present moment two different companies are projecting a canal across the Nicaraguan isthmus. One of these is called the Maritime Canal Company, the other the American Atlantic and Pacific Ship Canal Company. These two schemes are necessarily antagonistic, and their history is a record of constant struggles, diplomatic, financial, and otherwise, for a number of years past. It would hardly be profitable, although it might be very interesting, to look into the status, the claims, the prospects, and the proposals of the rival schemes. They have both the same end in view, and propose to attain it by much the same means. The Atlantic and Pacific Company propose to commence their canal at Greytown on the Atlantic, and to run thence in a general westerly direction to the San Juan River, the course of which they follow to the Lake of Nicaragua, which they traverse until they enter a canal that is cut into the Rio Grande; and, following the valley of the Rio Grande, they finally emerge near the Port of Brito on the Pacific. The canal follows its whole course through the State of Nicaragua. The company was organised under a grant from the Republic of Nicaragua in 1849. It does not, however, appear to have made any real progress in the furtherance of its scheme, and in 1856 all its property was seized, and the Nicaraguan Government annulled the grant made in its favour. From this time onwards to the present, the Canal Company and the Nicaraguan Republic have been negotiating, without any ultimate result. They have had a great deal of stormy correspondence, attended with recriminations, charges and counter-charges, confiscations, and restorations, that really look more like the petted play of spoiled children than the intercourse of public bodies engaged in a serious and memorable undertaking. The Atlantic and Pacific Company did, for a number of years, and pending the completion of the projected canal, carry on the business, under a special charter from the State of Nicaragua, of transporting goods and passengers across that State. But it does not seem to have carried on the work to the satisfaction of the Nicaraguan Government, and on different occasions its steamers, carriages, waggons, &c., were seized and confiscated, and were only restored on the payment of large sums of money. The chairman of the Company, in bringing these facts to the notice of President Cleveland, in a letter dated the 27th of February, 1888, maintains that the contracts and concessions originally arranged between the Company and the Nicaraguan Government are still operative, and that any contract made with any other company would be illegal. It is now, however, more than thirty years since this agreement was entered into. The full text of the concession is not before me, but from such provisions as the Company have thought fit to make public, it seems that the Government of the Republic granted to the Company the exclusive control of, and property in, the canal for a period of 85 years from the date of its opening, a concession that would hardly be in accordance with the provisions of the Clayton-Bulwer Treaty, seeing that the Company is an American one entirely. The most serious obstacle, however, in the way of the Atlantic and Pacific Company's concession being applied, is that the canal remains not only incomplete, but hardly begun. Whether this is owing to the inability of the company to provide the necessary funds, to the diplomatic difficulties already referred to, or to engineering troubles, there is little evidence to show. What is certain is that the Nicaraguan Government appears to have lost patience with this Company, and has, within the last few years, favoured the pretensions and claims of the rival company, which has recently been incorporated by the United States Government, and has at this moment a large body of engineers surveying the ground with a view to

* Senor Armero's Report to the Colombian Government.

adopting the most suitable route for their proposed canal through Nicaraguan territory.

The proposal to construct a canal *viâ* the Lake of Nicaragua, through the Republic of that name, is by no means a new one. It has, however, always been regarded as a most difficult, hazardous, and costly work. The climate, like that of the whole of the American isthmus, is extremely unhealthy, being liable to constant rainfall for three parts of the year. The Lake of Nicaragua is about 108 feet above the level of the oceans on either side, which involves additional difficulties, since every scheme that has been suggested has proposed to make use of this lake for a great part of the navigation across the isthmus. It has also been proposed, in almost every instance, to make use of the course of the River San Juan, which "falls by four mouths or channels into the sea;" which has "a current so strong that the flat-bottomed boats and canoes which navigate it are about nine days in ascending, and but 36 hours in descending, to and from the lake;" which has rapids so strong that "boats are obliged to unload at three places;" and which "in the dry season is narrow and impeded by shores."

From Lake Nicaragua, three different routes have been proposed for a ship-canal—the first to the Gulf of Papagayo, the second to the Gulf of Nicoya, and the third through Lake Leon to the port of Ria Lexa. Another route was afterwards added by Colonel Childs, which is described as "a short and easy one," to the harbour of Brito. The claims of each of these several routes have been discussed by geographers, hydrographers, and engineers, for nearly a century. They have been written upon and criticised, condemned and commended, described, denounced, and defended by such varying authorities as Humboldt and Funnel, Dampier and Robinson, Colonel Childs and Admiral Fitz Roy, Albert and Turnbull, the Earl of Malmesbury and the Emperor Napoleon III. The three first routes are chiefly interesting as having been those which, at an early stage of the proposal for a Nicaraguan Canal, divided the approval of the parties concerned. The fourth appears to "hold the field" at the present time, the scheme now under consideration providing for a canal which, commencing at Greytown on the Atlantic, proceeds *viâ* the San Juan River and the Lake of Nicaragua, to Brito on the Pacific.

Up to the present time there appears to be absence of exact and reliable information as to the configuration and character of the country that is to be traversed by the proposed Nicaraguan Canal. The district round about was explored more or less by Humboldt, who stated that the breadth of the isthmus, between the Lake of Nicaragua and the Gulf of Papagayo, on the Pacific, was about four leagues. Bastide, however, estimated the distance at three leagues; while another explorer, Robinson, puts the distance variously at twenty-one to twenty-five miles. The last-named authority declared that the shore of Papagayo "is so bold that a frigate may anchor within a few yards of the beach;" but Funnell, whose account is regarded as trustworthy in the main, declared that not only were there no facilities for landing, but that the Gulf of Papagayo "does not contain any suitable port, or any shelter, landing-place, or other available requisites for the construction of an artificial harbour." To the Gulf of Nicoya there appear to be equally formidable objections.

In Dampier's time there was a road for the land carriage of heavy and bulky goods between Nicoya and the Lake of Nicaragua. The country, however, is very hilly, and is not well adapted for the passage of a water-way, while the town of Nicoya is not provided with a harbour, the shores of the gulf being very shallow, and dangerous to shipping. The third route from Lake Nicaragua, through Lake Leon to the port of Ria Lexa, has been approved by some and condemned by others. Humboldt described the route between Ria Lexa and Leon as "twenty miles in length, flat, and covered with mangle (mangrove) trees." These trees, however, are usually grown in sea-water marsh or swamp, so that there is a presumption that the country will be extremely unhealthy, and that the pestilential diseases which have wrought such havoc among the canal *employés* at Panama, would be quite as deadly on the line of this enterprise. In the selection of the route now proposed for the Nicaraguan Canal—proceeding from Greytown, on the Atlantic side, until it joins the San Juan River above Rio Colorado, and following the course of that river until it reaches the lake—it is assumed that the lake will be crossed without involving any engineering operations, but on its opposite shore the canal is to be continued by way of the River Del Medio, until it debouches on the Pacific at the harbour of Brito. The total distance from ocean to ocean is estimated at about 180 miles. As, however, the San Juan

river and the Lake of Nicaragua are to provide 127 miles of the proposed navigation, the estimated length of the distance to be canalised is only 53 miles, of which 36 miles are on the Atlantic, and 17 miles on the Pacific side of the isthmus. The real distribution of the route would, therefore, be as under:—

Navigation of the San Juan river ..	60 miles.
,, Lake Nicaragua ..	67 ,,
Canal on Atlantic side	36 ,,
,, Pacific side	17 ,,

It is necessarily impossible to fix, even approximately, the cost of this great enterprise. It has been estimated at £20,000,000 sterling, which is about one-sixth part of the sum at which the most recent estimates put the cost of the Panama Canal. The former enterprise, as originally planned, was to have three ship locks between Greytown and Nicaragua, and four locks between that lake and Brito. The lockage lift of the three locks on the San Juan river is calculated at 106 feet, being 26 feet for the first, 27 feet for the second, and 53 feet for the third. The four locks on the Pacific side are estimated to have a lockage lift of 110 feet, being 26 feet for the first, 29 feet for the second, 30 feet for the third, and 24 to 33 feet for the fourth, according to the rise and fall of the tides. The length of the locks will be 600 feet, their breadth 65 feet, and their depth 30 feet; the cost of constructing the whole seven locks is estimated at £1,665,000. Additional sums of £323,000 and £355,000 respectively are proposed to be expended in improving the harbours at Brito and Greytown. The promoters maintain that a ship can be passed on from the Caribbean Sea to the Pacific Ocean by this canal in about 30 hours, and that it will be equal to a traffic of 11,680 ships, or 12,000,000 tons of shipping per annum.

The American nation, to whom it is more important than to any other that a ship canal should be constructed across their isthmus, whether it be by way of Panama, Nicaragua, or Techuantepec, appears to be more favourable to the Nicaraguan project than to either of the others. Last year it was reported that the Senate had adopted, in secret Session, a resolution advising President Cleveland to enter into negotiations with the Republic of Nicaragua, in order to obtain the necessary concession for the proposed canal. That concession has since been obtained by the Maritime Ship Canal Company, but it is threatened with annulment, as we have just seen. It is generally believed in the United States that the Nicaraguan Canal will really be carried out, whereas the Panama scheme is largely regarded with disfavour and doubt. Too much importance, however, must not be attached to this circumstance, since there may be a certain amount of jealousy of M. de Lesseps and his coadjutors. Nor must we forget that a canal has been under consideration for nearly a century, while several companies have been formed and quite a number of schemes projected with a view to its construction, without any actual progress having been made, until M. de Lesseps put his shoulder to the wheel.

It is hardly possible for us to consider the vast interests involved in the establishment of a canal between the two oceans, without feeling solicitous that if such a water-way is to be opened up, the maritime interests and the unequivocal rights of Great Britain shall not be ignored. We have a greater stake in this enterprise than is commonly supposed. Scotland was all but ruined by the ill-starred project which Paterson devised 200 years ago, in order to colonise the Isthmus of Darien, and to establish over it a carrying trade from the Eastern to the Western world. For considerably more than two centuries we have claimed to exercise a protectorate over the Mosquito coast, now incorporated in the State of Nicaragua, and we have actually, within the present century, unsheathed the sword on behalf of the Mosquito Indians, and have restored to them the port and town of San Juan, or Greytown, which is to be one of the termini of the proposed Nicaraguan Canal. Some of our ablest engineers have surveyed the isthmus at different times, with a view to the opening up of a water-way from ocean to ocean, and if our maritime supremacy be considered, such a project should be of infinitely greater value to us than to any other State.

If a canal is to be carried across the American isthmus, the work should be undertaken, not by one nation, or State, or company, but by a convention of great Powers, responsible for the expenditure which it would involve, for the due and efficient completion of the undertaking, for its neutralisation, regulation, and maintenance. The three countries mainly interested are England, France, and the United States. The Governments of these three countries have already co-operated in the directions indicated, having, in 1854-55, jointly promoted a survey undertaken by Mr. Gisborne, and subsequently described in the

Proceedings of the Royal Geographical Society.* There is a growing feeling in France that the Panama Canal should be taken up and completed in this way. The editor of the *Economiste* recently recommended, in express terms, that application should be made to the great Powers for a collective guarantee on the £40,000,000 or £44,000,000 sterling estimated in France as required to complete that undertaking, and added that failing the success of such an application, "France has no occasion to impoverish herself by playing the part of Don Quixote, and trying to cleave mountains at thousands of leagues from her shores."†

DISCUSSION.

Sir Douglas Galton, K.C.B., said this was a subject which he had not followed very closely, although he took an interest in it at the time the surveys were made in 1885-6 by his relative, Mr. Lionel Gisborne, who in the course of those surveys contracted an illness from which he eventually died. There was one point to which no allusion was made, not a canal across the isthmus, but that most ingenious suggestion, the project made by Captain Eads, to make a ship railway between the two oceans instead of a canal. Unfortunately, Captain Eads died last year, and left his project unaccomplished, but that it was feasible, and would have solved many of the difficulties connected with the canal, there could be very little question amongst those engineers who saw the admirable models which Captain Eads brought to England, and the detailed scheme he produced. The scheme was not an American one entirely, but was much the same that Mr. Brunlees originally produced for a ship railway in Honduras. It was proposed at the same time that Mr. Gisborne made his surveys in Nicaragua, but fell flat at that time.

C. De Tankerville Chamberlaine Bey said he would not enter into the question of the relative merits of the two canals, as he had the pleasure of knowing Colonel Blackman, the President of the Nicaragua Company, and was also an intimate friend of M. de Lesseps, but having had experience and local knowledge of the Panama Canal he would give an account of what was being done there, having only returned some seven months ago. Nicaragua was a volcanic country, and the distance from the San Juan River to Port Realejo was much greater than from Colon to Panama; it being above 200 miles, while the other was 47½. Columbia had vast resources, including gold mines; its superficial area was 330,000 square miles, so that it was nearly twice as large as France, but had only a population of 4,000,000. Nicaragua was a small republic in comparison. The cost was very doubtful. In the International Congress, in Paris, the sum of 873,000,000 francs was voted for the construction of the Panama Canal, but this was all theory, and it will be the same with that of Nicaragua. The Panama Canal was estimated to cost £35,000,000 sterling, when the Congress took place, but in January, 1888, it had cost actually £36,000,000. M. de Lesseps at this moment had £5,000,000 in cash, and on the 14th of March last made a loan of 50,000,0000 francs. There was also a request to the French Chamber to obtain for him a lottery loan of £24,000,000, which, if he obtained it, would make the £30,000,000 which were actually necessary to finish the canal. He did not see why there should be so much opposition in England and America, where they had embarked so little in it. It was a gigantic work—a humanitarian marvel—one of the grandest things in the present century, and if it were opened, nobody knew what development would take place in those parts of the world. All down the coast of South America, from Cape Horn, up to San Francisco and Alaska, there was an immense traffic waiting to be developed, when the hyphen was taken away which divided the oceans; and he did not see why there should be any opposition; there must be some other reasons. If the canal cost £100,000,000, it was not English or American money that was paying for it, but France had subscribed nearly the whole amount. The financial question was another question altogether, but he did not see why those who were interested in civilisation should try to obstruct its progress. At this moment the canal was opened from Navy Bay for 15½ miles, to ships of 1,500 tons. The Mindi Rock had now been blown up, and the passage was free for ships to come up to Buhio Soldado. The American Contract and Dredging Company contracted to remove from 28,000,000 to 30,000,000 cubic yards, and 100 per cent. had been paid on the shares of that company, so the Americans had no reason to complain. Going on from Buhio Soldado to Gorgona, and on to Culebra, the canal was in process of construction. In 1881, it was estimated that 125,000,000 cubic metres would have to be extracted, and, between that time and 1885, it was difficult to describe the hardships the staff went through; the climate was far from healthy, and a great part of those four years had been occupied in cutting an opening across the isthmus, the building of huts and houses for the surveyors, and bringing together the negroes from Jamacia, Barbadoes, and other places all round the Caribbean Sea, who came to offer their services, and who were all British subjects. In 1887 it was found that out of the total of 125,000,000 cubic metres only 17,000,000 had been extracted, so that 108,000,000 were still remaining, and the canal was to have been opened in 1889. This task being evidently impossible, M. de Lesseps called a Consultation Committee in Paris, and remarked that it was impossible to make the

* *Journal*, June 9th, 1856.

† *Economiste Francaise*, February, 1888.

canal as originally designed (a tide level canal), and inaugurate it in two years. It was then decided that ten locks should be constructed, five on the Atlantic side and five on the Pacific. The first lock was to be at Buhio Soldado, with a width of 330 feet, at the entrance of Fox River. Thence up to Culebra the total rise was 124 feet. The gates of each lock were 70 feet wide, and the lock itself was 590 feet in length. In this method of construction there would be only 34,000,000 cubic metres to remove. By February of this year 1,500,000 had been extracted, and if that rate were continued, he was firmly convinced that the work would be completed in the course of three years. The two great engineering difficulties were the Culebra and the Chagres River; both had now been overcome, the former by altering the plan to a lock canal, thus saving an immense amount of excavation, and the latter by diverting the waters of the Chagres to the Fox River, so that instead of crossing the canal 25 times, as it now did, it would be carried away to the eastward in a bed the same size as the original one. The dam was to be only 300 feet long and 25 feet high, though originally it was to have been much larger. When the freshets occurred the water would be turned back in the valley, which would contain 600,000,000 cubic metres, whence it could flow, let out as the engineers of the canal desired. He was a zealous disciple of M. de Lesseps, as well as his great admirer, and had always had confidence in the Panama Canal, which he felt sure would be opened in 1890, notwithstanding all that had been said by its decriers, and hoped then to have the pleasure of going through it with M. de Lesseps.

Mr. R. W. Belch said he should like, on behalf of Colonel Blackman, to correct one or two statements as to the Nicaraguan Canal. The canal of the American Atlantic and Pacific Ship Canal Company was 194 miles long. Its charters and rights were taken away by the Nicaraguan Government in 1856, but were renewed in 1857, and subsequently renewed and enlarged in 1886. Some of the reasons why the canal had not been constructed were as follows:—In the first ten years of its life, gold having been discovered in California, there was such a rush across the isthmus to get there that the company turned its attention to transport, and obtained a new charter, under which they conveyed more than 150,000 people to the new Eldorado. From 1860 to 1870 the American War interfered with anything being done, and as the Nicaraguan Government had been in the habit of granting concessions to anyone, giving one to M. Bellè, to M. Chevreul, to Captain Pim, and others, all for the same purpose of constructing a canal, it could easily be understood that when they wanted to raise a little cash they simply seized the property of the company, and said, If you will pay so much you shall have it back again. On one occasion the agents of the company rolled several barrels of silver in at the front door of the President of the Republic, and when that was done they got their steamers back. Sometimes they paid £20,000, sometimes £30,000 but they could not go on doing that for ever, and in 1868, when the Government seized their steamers for the last time, the company ceased to act. It had, however, never surrendered its rights, or ceased to exist. The scheme of the Maritime Canal Company, of which Mr. Menecol was the head, had not been chartered by Congress, as Mr. Jeans stated; it had applied for a charter of incorporation; why he did not know, for it seemed to him that Congress might as well grant a charter for constructing a canal from Hyde-park to the House of Commons, but the object had been officially stated to be that of influencing European capital. With regard to the healthiness of Nicaragua, he could state that no one connected with any of the surveying expeditions had died there. The canal route, though 194 miles long, varied so much in width, and where it passed through the lake was so large that steamers could go at full speed, and the time occupied in the transit would thus be less than by the canal, which Mr. Chamberlaine had so graphically described. The ship railway scheme of Captain Eads was considered in the United States to be dead, at any rate for the time, the enthusiasm with which Captain Eads backed it up having died with him. He did not wish to criticise the sections of the Panama Canal put forward by so friendly an opponent as Mr. Chamberlaine, though he did not think they were quite adequate. The enmity in the United States, to which reference had been made, probably arose from their partiality for their offspring, and seeing that the other infant was growing so rapidly they could not be blamed for being anxious to take the only dividend which they thought would ever come out of the canal. The quotation made from the *Edinburgh Review* was he thought rather misleading, because it went on the assumption that the whole work of excavation would be done with a pick and shovel, whereas, of course, the most modern engineering appliances were being employed. It should also be mentioned that whilst £35,000,000 or £36,000,000 sterling represented the amount which had actually been expended, it did not by any means represent the nominal amount upon which interest would have to be paid. Mr. Jeans might have said more as to the probable effect of opening the canal, and it was singular that the French should have so much to do with it, because the advantages would be almost wholly reaped by the English and Americans. The basin of the Caribbean Sea, the moment the canal was finished, would support an enormous commerce, the amount of which it was impossible to estimate. That sea commanded an area which gave every variety of climate and temperature, and in which there was always a crop on the way to market, for when it was winter in one place it was summer in another. The canal would reduce the journey from

New York to San Francisco by 14,000 miles, and would bring Liverpool really within a short trip of that port; in fact, it was the key of the Pacific; and the question of what it would do in developing Nicaragua, or Colombia, was of little importance in comparison to what it would do in developing the commerce of England and America. It might be taken for granted that the Nicaraguan Canal would be made, for whatever might be the legal position of Mr. Menecol's and Colonel Blackman's companies, they would eventually be one, and the canal would be built by American and British money. Two of the most distinguished engineers in England had seen the plans, and said it could be built for 45,000,000 dollars less than any other canal route across the American isthmus. With regard to the amount of commerce waiting for such a canal, the latest estimate made by the Committee of Commerce of the American House of Representatives this year gave the total amount at present at 9,000,000 tons, so that he thought there would be at least 10,000,000 when the canal was opened. While he should be very glad to see the Panama Canal constructed, he would also, as representing the Nicaraguan Canal Company, invite Mr. Chamberlaine, and other gentlemen present, to the opening of the Nicaraguan Canal.

Mr. R. Price Williams thought all who had heard the paper would agree in the conclusion that this should be an international work. As an English engineer, he thought it little less than a crime that two great works of this kind should be constructed, when one alone proved such a tax on the resources of those who had undertaken the task. To England especially, which carried about 74 per cent. of the commerce of the world, it was of the greatest importance to have a communication between these two great oceans. He had listened carefully to the account of the engineering difficulties, but the author had given but a hazy account of the engineering features of the Nicaraguan Canal, or the estimated cost. It was clear that the lowest estimate would be £34,000,000; they knew in the Panama case how different the result had been to the original estimate, and as far as he could judge, the engineering difficulties of the Nicaragua route was equally as great as those in Panama. He had frequently had the privilege of going through the Suez Canal, and believed that none of the difficulties referred to in the paper were by any means insuperable. Looking upon it as an international matter, he thought it was a disgrace that England had taken so little interest in it. He would venture to suggest that the co-operation should be invited of French and English engineers, and he did not see why Germans also should not be invited, for within the last year, when travelling from San Francisco to New Zealand, he was a great deal in the company of a prominent German, from whom he learnt what a great interest the Germans had in the Pacific. He thought there would be a splendid opportunity for the French and Germans to put their heads together and, instead of accumulating war armaments, see if they could not devote their resources to more rational purposes. The complete revolution which had followed upon the opening of the Suez Canal showed how important the results of such enterprises were. However great the merits of the Nicaraguan Canal might be, he considered it would be a crime to proceed with it until the Panama Canal was constructed, and he hoped all engineering ingenuity and monetary influence would be devoted to the completion of the latter.

Mr. John Barker desired to call attention to one or two points bearing on the financial question. The amount received up to 1877 for the Panama Canal was £41,837,477 in hard cash, the new obligations being £24,000,000, making a total of £65,837,477. The interest and sinking fund on this £41,837,477 was £2,816,281, or 6·73 per cent. The nominal capital of the company up to 26th July, 1887, was assumed to be about £71,500,000, to which must be added new issues to the amount of £24,000,000. In his last report M. de Lesseps gave an estimate of the total cost of the canal, showing a surplus of about £2,240,000, amply sufficient to pay the service of the loan of 600,000,000 francs up to July, 1890. M. de Lesseps, further taking the tonnage amount to be levied on 7,500,000 tons, calculated the balance of income for dividend, after the canal was opened, at 21,292,190 francs, or equal to 7 per cent. on the shares. M. de Lesseps was a very sanguine man; he was not an engineer, but he was a very clever man with figures, and he had proved their correctness in the Suez Canal.

The Chairman said they had not only had a very valuable paper, but it had been ably supplemented by two gentlemen well and practically acquainted with the two routes. Some reference had been made to the mistrust shown in regard to the Panama Canal, as there had been with reference to the Suez Canal, but he could not quite agree with Mr. Barker that the original estimates made by M. de Lesseps, with regard to the Suez Canal, were carried out in such a way that absolute confidence could be placed in the figures put forward with regard to Panama. The circumstances of the Suez Canal and its engineering conditions were totally different from those of the Panama schemes, and although the opinion of Mr. Price Williams was very valuable with regard to the local conditions, he was rather surprised at his treating the two as parallel cases, for Suez was level and the other was not. The real cause of the mistrust of M. de Lesseps' proceedings originated with the Suez Canal. He undertook on that occasion a large work, in which French commerce had a very small part, but in which English commerce had a very large part, and he proposed to use it as a political engine, and the same thing was really taking place with regard to the Panama

Canal. He was not at all surprised, having been the advocate of M. de Lesseps, with regard to the Suez Canal, that Lord Palmerston should have considered it his duty to protect English and European interests in Egypt, having regard to the proceedings of M. de Lesseps, proceedings of a purely political character, and he had acted in much the same way on the other side of the Atlantic. Mr. Price Williams seemed very much surprised that Englishmen had taken so very small a portion in this undertaking in which they were ultimately to have so large an interest, but to those who knew the facts, it was by no means surprising. He (the Chairman) had had a long connection with the country through which the Panama Canal was being carried, and he applied officially to M. de Lesseps, calling his attention to the desirability of forming a committee of English capitalists and merchants, because they were chiefly interested in the trade of that country, but he did not even get the papers three times promised. They were quite prepared to have formed a committee of co-operation in this country, but it was evident that M. de Lesseps was not prepared for such a committee of co-operation, which might to a certain extent have been a committee of superintendence. It was not Englishmen who had abandoned M. de Lesseps, it was M. de Lesseps who had abandoned us, and in the same way he had gone into that country where Americans had the predominant political interest, and it was by no means surprising that they were not disposed to place full confidence in him; on the contrary, it was only natural that they should be mistrustful of his engineering and financial success. One very important point referred to in the paper had been brought out more fully by Chamberlaine Bey. The canal, as originally proposed, was to be a tide-level canal, but they knew now that it was to be a lock canal, which was a totally different thing. M. de Lesseps had changed his basis altogether. Chamberlaine Bey had mentioned the fact that the canal was now open for 15 miles on the tidal level, or he should have done so himself, but that was only a small portion of the tide-level canal which was promised to the world. The fact was, that the difficulties and mistrust were caused by M. de Lesseps himself. With regard to the Suez Canal, the negotiations going on lately showed how seriously the peace of the world had been endangered by his proceedings in Egypt, and no one could tell what would be the result of these proceedings of his in Central America. He was not at all surprised that the Nicaraguan Canal should be pushed forward by the Americans, as they had the strongest interest in opening communication between the two oceans. Mr. Jeans had given the history of the Nicaraguan Canal, but had not referred to the part taken in this country in connection with it, some 60 years ago. He recollected it as a boy, because his father was one of the directors, and contributed a large sum for the surveys. The company was called the Atlantic and Pacific Ship Canal. Prince Napoleon afterwards took it up, and he was in correspondence with him on the subject. The account given by Mr. Belch of the proceedings in Nicaragua was known to all who had anything to do with Central America. One might wonder that Colonel Blackman should again attempt to carry on that undertaking after the oppressions to which he had been subjected by the local governments. Mr. Belch had not done full justice to Colonel Blackman's plans, for he had been given to understand on competent authority that his plans of lockage were of a remarkably practical character; so far from agreeing with Mr. Price Williams that they ought to abandon the Nicaraguan Canal for the Panama, after all the details they had heard with regard to the engineering and financial proceedings of M. de Lesseps, it really seemed to him most prudent on the part of the Americans to push forward the Nicaraguan scheme as far as they could. Even if the Panama Canal should be completed, either in the lock form or ultimately as a tide-level canal, there would be work for both. Indeed, it was now a question of two lock canals, and no longer a tide level canal against a lock canal. As to an international assembly for the purpose of carrying out the work, M. de Lesseps had already put aside international co-operation. It was not possible to form a co-operation which should include the French, for they had really no commercial interests in those countries. The commercial interests in the Pacific ocean were in the hands of the Americans and English. It was very desirable that we should unite with our brethren on the other side of the Atlantic to carry out the Nicaraguan Canal, and to watch very closely the Panama Canal. There would always be in this country a good feeling towards it, but there had been no opportunity of exercising the legitimate co-operation and legitimate influence which our authorities entitled us to. He was glad that Sir Douglas Galton had referred to the Techuantepec Ship Railway of Captain Eads, for it was possible that, if there were such difficulties in connection with the Nicaraguan Canal as had been shadowed forth by some persons, this beautiful and practical arrangement of the great engineer of the Mississippi might be the means of overcoming them. He was also glad that the name of William Wheelwright had been mentioned, for he ought to be better known to Englishmen as the pioneer of steam navigation in the Pacific. He concluded by moving a hearty vote of thanks to Mr. Jeans.

The motion having been carried unanimously,

Mr. JEANS, in reply, said he should be only too pleased if Chamberlaine Bey's estimate of the time when the Panama Canal would be opened turned out to be correct; but he understood him to say that there were still 34,000,000 of cubic metres to be excavated, and he found that the Anglo-Dutch Company, to whom the contract was let at an early stage, were not

able to do more than 100,000 a month. At that rate it would take a good many years to carry out even the modified plans. He was very glad to have Chamberlaine Bey's criticism, because he had really added materially to the information he had been able to supply. He was also pleased to have Mr. Belch's remarks on the subject of the Nicaraguan Canal, because he knew he was thoroughly conversant with it. He had, like Mr. Belch, lately had the privilege of seeing Colonel Blackman's plans, but was not authorised by their author to say anything about them at the present moment. He hoped, however, that they would be made public soon, and then they would probably excite a good deal of interest, as two very distinguished engineers had reported that they were the best plans for crossing the isthmus which had yet been put forward. Though he knew most of the salient facts about Colonel Blackman's scheme he had been obliged to refer in detail only to the plans of the Maritime Company. He had been taken to task for quoting some remarks from the *Edinburgh Review*, as being likely to mislead, but he did not think there was any danger of that. He only quoted them to show what extremely absurd opinions were put forward by people who ought to know better, in a leading periodical. Those who were aware of what had been done in crossing the Isthmus of Suez, and more recently in Panama, must be aware that the idea of taking 24 years to carry out this undertaking was sheer nonsense. Though he was not prepared to endorse Chamberlaine Bey's opinion that the Panama Canal would be open in two or three years' time, he was still disposed to believe that it would ultimately be carried out, and he had such a high opinion of the enterprise and ability of those connected with the Nicaraguan Canal, that he believed that scheme also would become a *fait accompli* before very long. He did not share Mr. Price William's opinion that it was a disgrace that there should be two canals. On the contrary, the history of the Suez Canal taught such a lesson with regard to the enormous development of commerce when facilities were provided for it, that he should not be surprised if (within half a century) both canals were in full swing, and doing as much business as they could manage. The Chairman said that so far from English people having abandoned the great engineer, M. de Lesseps had abandoned us, and had quoted examples of what looked something like a lack of courtesy on the part of that gentlemen; but he thought probably there were two sides to the question, and that M. de Lesseps might think he had cause of complaint against us, remembering the early history of the Suez Canal. Mr. Belch had contested the fact stated as to the incorporation of the Maritime Canal Company; but he found it stated in the *Times* of April 1st last year, that the American Senate (not Congress) had passed the Bill incorporating the Nicaraguan Canal Company.

Miscellaneous.

THE CULTIVATION OF INDIA-RUBBER PRODUCING TREES.

By Thomas T. P. Bruce Warren.

The notes which appeared in the *Journal*, No. 1,833, vol. xxxvi., on the Royal Botanical Gardens, Nilgiris, are interesting to everyone who would wish to see our own country and its dependencies producing those products which we are obliged at present to go elsewhere for.

The better descriptions of india-rubber, which are obtained from Brazil, and Central America, are now so eagerly sought after for the markets of the United States and Germany, that this important industry is no longer a monopoly of this country. England is the birthplace of this manufacture, and although we need not fear, perhaps, for some time, but that we shall sustain our supremacy in the manufactured products from india-rubber, we must not rest in comfortable assurance that the markets for our produce are unassailable by the foreigner. Let us bear in mind, too, that our Yankee friends are so frequently at Para, that they have virtually the run of the market for the raw article there, so that we have, no doubt, to take, in many cases, what would not pass muster for them.

I remember, some years ago, when I was at Para, we wished to load up with a cargo of rubber, &c., for London. In the first place, there was no rubber at all at Belem (Para). An American ship had called the day before, and had absolutely cleared out all the rubber from all the stores. As we were not leaving for a few days, our agent there undertook to look out for us; he secured about 400 tons of mixed cargo, consisting of india-rubber, balsam copaiba, &c. In addition, we were the bearers of her Majesty's mails, consular reports, bullion, &c.

I shall not readily forget the odour of that cargo, and on going there again some time after, we preferred coming home empty, when we were asked the day before leaving to carry 400 tons of rubber, a large portion of which was consigned to a manufacturing firm in Manchester.

India-rubber is invariably carried to Liverpool for our own supply, and we could only secure the carrying these cargoes at the Liverpool rates for freights. Now a London manufacturer is placed at a disadvantage compared with one residing near the port of unloading, for to the market price at Liverpool must be added the cost of transit here, which, although not very great, is so much off his profits, and in these days of competition cannot be disregarded.

If, then, india-rubber can be cultivated in our colonies, it can be brought home on English bottoms, and probably carried to ports nearer our centres of

consumption. Liverpool has no claim as to proximity of factories; the run from America to Liverpool being shorter is the only inducement, and this benefits the shippers only.

The india-rubber of Central America is obtained from varieties of *Castilloa*, which yield rubber very little inferior to that obtained from the *Siphonia*. To raise india-rubber plants which are indigenous to one place in another where the conditions are at all favourable is no difficult task, but to make the same plant successfully productive is another matter altogether.

I have often thought that the collection of india-rubber does not receive the attention which it should have. How many are aware of the influence which handling raw rubber with dirty or sweaty hands has on its decay? The greasy character of the perspiration of some negroes especially is well known; even if india-rubber is handled much in this country it is sure to show signs of decay in the parts most exposed to this after some time.

It would be interesting to know how far the great difference between the African and American raw products are due to this? The less the raw article is fashioned by the hands, in handling, the better. The American varieties are not touched at all when fashioning the forms of the better varieties; to this must be added the fact that the Brazilian creole does not give off that fatty perspiration which a black native does. Grease of any kind, even in small quantity, is most pernicious to the durability of raw rubber.

Too much attention caunot be drawn to this subject, and if plants can be cultivated so as to yield rubber successfully, we must take care that our efforts in collecting do not add to the depreciation of the product. When rubber shows these signs of decay, dusting over with sulphur will tend to arrest it

I omitted to mention that a railway runs from the American producing districts to the manufacturing centres. We ought not to overlook this fact in calculating our commercial status in the markets of the world.

Correspondence.

SCIENCE AND ART DEPARTMENT.

Everyone who wishes well for the future of the Science and Art Department must regret that Major-General Donnelly, in taking up my remarks upon the relations of that Department to the technical instruction question, has avoided the main issues which I raised. With his last letter I will deal presently, as it is concerned only with minor matters.

For years it has been only too well known to those who were acquainted with the actual working of the Science and Art Department scheme of national science-teaching and art-teaching, that it presented many unsatisfactory features. The Department's way of promoting the spread of scientific education, good though it may have been at the time when it was founded, had largely degenerated, under the debasing effect of payment by results, into the mere cramming for examination for earning grants and prizes in certain five-and-twenty specific subjects, under a rigid code which had little or no relation to local industries, or to the definite applications of science to trade. The regulations presented extraordinary absurdities and anomalies, some arising from the refusal to recognise any science outside these five-and-twenty subjects, others from the awkward internal grouping of several sciences under one "subject;" others from the strange and unhealthy restrictions placed on teachers; others from restrictions placed on the teaching of the higher branches. Those teaching under the Department's rules know these things well enough, and have long chafed under them. Strangely enough, the outside public knows little of these matters. So long as the Science and Art Department did not pretend to be doing more than promote, in its own way, the spread of elementary education in science and in art, there was no great reason to complain of these blemishes and anomalies in its system. But directly it was proposed, in the Technical Instruction Bill of last year, to hand over the technical education of the country to the *régime* of payment by results, of examinational cram, of the five-and-twenty specific science subjects, or as many more as the Department might choose, the situation was changed. It became the bounden duty of those who knew the defects of this system to speak, and to speak plainly. I did so in a letter addressed to the *Times*, in which I gave voice to a number of matters which had been for long notorious. Not one single point in my criticism was publicly challenged. It is easy to show how utterly at variance the regulations of the Science and Art Department are with that which is required for really *technical* instruction. Take, for example, the subject of building construction and design—one of the five-and-twenty specific science subjects. Now one would have thought that, for the teaching of this subject to be of any use, the prime qualification of the teacher would be that he should have a technical knowledge of the subject—that he should himself have worked at building, either as builder or architect. But what do the official rules lay down as a qualification? Anyone is recognised as qualified to teach this or any subject who has taken "a degree at any university of the United Kingdom," or who has passed at least a second class in the advanced stage at the May examination in the subject, or who is a teacher on the staff of a training college, or who had a "third grade art certificate" before 1869 (which certificate had nothing to do with either building or civil engineering). There is not a word in the rules requiring, in the most remote way,

that the teacher of building construction shall have had any technical acquaintance with the subject of building. The fact of having properly learned building construction in a builder's or architect's office is not recognised as any qualification at all. I particularly request Major-General Donnelly to contradict me if I am wrong. I give this as a sample of the way in which the Department's regnlations on the one hand tend toward scholasticism, and on the other prevent the science teaching from having any technical value. Of the scores of "science teachers" who are supposed to be teaching building construction in the various classes held up and down London at the present time, how many have any knowledge of building? It is no use asking Major-General Donnelly for the information, simply because, as the Science and Art Department requires no technical qualifications in its teachers in this subject, it has no statistics of information to which he can refer to say how many of them ever were occupied in a builder's or an architect's office. Probably not three per cent. of them ever were.

Many similar anomalies might be pointed out. Space does not here permit me to do more than to point out how, under the Department's official rules optics is not recognised as a science. Aid is not given towards instruction in this object, unless it is accompanied by instruction in one of two other subjects (acoustics and heat), which have nothing whatever to do with technical instruction in optics. The one science subject that touches the musical-instrument making trades is the science of acoustics; but the Department does not pay for classes in this unless accompanied by either instruction in optics or in heat. This regulation virtually boycotts all real technical teaching. A skilled optician, teaching the principles of optics to optical instrument makers' apprentices, or a skilled organ builder teaching acoustics to a class of musical instrument makers' apprentices, would neither of them receive any recognition from the Science and Art Department, however excellent the teaching. On the other hand, if an M.A. of the University of Lampeter were to cram up a class for the triple subject of "sound, light, and heat," however superficial the teaching might be, he would be entitled to receive payment on results, and his pupils would be eligible to win prizes. Clause xxiv. of the official "Directory" states that the May examinations are open to all candidates, but Clause xix. (p. 8) mulcts the students who have earned prize of that which they have won, if their teacher does not fulfil the arbitrary qualifications laid down as mentioned before. Clause xxi. (p. 36) of the official "Directory" boycotts honours students—or rather, their teachers—if their previous training has been outside the Department. Clause viii. (p. 3) boycotts free education. I know of a certain large town in the north of England, where there exists an extensive local voluntary organisation for carrying out free science classes. Its work, excellent, as I can bear witness, is, by this clause, put out of recognition; its teachers cannot receive the grants, nor the pupils the prizes offered by the Department to those who may pass the Department's examinations.

Now, this is the kind of thing which, coupled with many other similar matters, visible enough to those who do not look through official spectacles, has made it clear that the Science and Art Department, *as at present constituted*, is not the body to which the great national interests at stake in technical instruction should be committed. Fully admitting the good work which the Department has done in the past, I nevertheless maintain that to turn over technical instruction to the *régime* into which our national system of science and art education has drifted will be simply ruinous to the movement. I have felt this strongly; I have tried to say so as plainly, as deliberately, as forcibly, as I could I am glad to see that Major-General Donnelly, at least, has not fallen into the mistake of thinking (as, I am told, some of my friends have done) that I have attacked, or have any desire to attack, the able administrators of the Department of which he is the chief. It is their system—its fossil regulations, its unfortunate anomalies, and its fatal restrictions—that I attacked, and, so long as the necessity remains, shall continue to attack.

I had earnestly hoped, when I found that my speech at the Society of Arts had come under the cognisance of Major-General Donnelly, that he would have addressed himself to the matters of really national importance. I had hoped that, whilst admitting the existence of these defects, he would at least have given some hopes of attempts being made to remove the many causes of complaint. I may freely admit that the bottom would be knocked out of much of what I have said, if in a single word, Major-General Donnelly had indicated that the Department was prepared to throw over its absurd restrictions on teachers, and allow specialists who have the technical knowledge to be chosen by the local committees, irrespective of their fulfilling the present arbitrary qualifications. My charge that the regulations of the Department tend to produce superficialism in both teacher and student—witness the vast array of little cram-books which have grown up *propter hoc*—might have been equally disposed of by an assurance that this should not continue. But no, my hopes have been disappointed. Instead of addressing himself to the really important national issues at stake—and which, as I say, I endeavoured at least to raise in a plain and unmistakeable way—Major-General Donnelly passes them all aside to split straws about two semi-personal points.

He objected firstly to my using the word "scholarship" in a general way which would include "studentships in training," as well as national scholarships and (not "or," as Major-General Donnelly wrote last week) royal exhibitions; and secondly, he sought elaborately to show that the reason given to me thirteen years ago for allotting me a place in Professor Huxley's laboratory instead of Professor Frankland's (namely, that my examinations in physiological subjects were weak as compared with those

in chemistry and physics), was not the real reason, but that the real reason was something to do with the capacity of the school for studentships in training in chemistry, which, in spite of the fact that I subsequently entered the chemical department by payment, were "full." I really do not think it worth while to follow the last turn of these entirely unimportant issues. Major-General Donnelly assures me that my "studentship in training" was not a scholarship "of any kind;" an assurance which I am bound to accept as being officially true, in spite of the fact that when I gave it up I had to relinquish something like £80 which it was worth. I am not disposed further to dispute that the number of studentships in training was "fixed by" the capacity of the school. Major-General Donnelly speaks with official information. As there is then no longer any need to discuss these petty and semi-personal details, the way is open for the return of the discussion to those questions of national importance which I have done my best to state in plain terms.

SILVANUS P. THOMPSON.

27th March, 1888.

Obituary.

SIR CHRISTOPHER RAWLINSON.—Sir Christopher Rawlinson, a member of the Society of Arts since 1870, died on Wednesday, 28th ult. He was born in 1806, and graduated at Cambridge University, B.A. 1828, M.A. 1831. In the latter year he was called to the bar at the Middle Temple, and in 1840 was appointed Recorder of Portsmouth. In 1847 he became Recorder of Prince of Wales's Island, Singapore, and Malacca, and was knighted in 1849. He was Chief Justice of the Supreme Court of Madras from 1850 to 1859.

General Notes.

BARCELONA EXHIBITION.—Information has been received from Sir Clare Ford, the British Ambassador at Madrid (through the Foreign-office), that the Exhibition will be opened on 8th April, the original day fixed. On the day following the ceremony the Mayor of Barcelona will proceed to Madrid, and invite the Queen Regent, in the name of the City of Barcelona, to visit the Exhibition. Her Majesty has consented to inaugurate the Exhibition on the 15th May.

SILK ASSOCIATION.—A meeting of the provisional committee of the Silk Association of Great Britain and Ireland has been held at Manchester (Mr. Thomas Wardle, president, in the chair), when the first council of the Association was elected. It was resolved that a meeting of all the silk dyers and finishers of Great Britain should be called, to consider how silk dyeing and finishing can be best represented and promoted by the Silk Association, and also that a meeting of the Council should be held in London during the silk sale week in June next.

IRISH EXHIBITION.—An Irish Exhibition will be held at Olympia, Kensington, from June 4th to October 27th, with the objects (among others) of placing before the English public a clear view of the predominant industries of Ireland, and of illustrating the worth and significance of Irish art. The heads of the classification of exhibits are as follows:—(A) Agriculture; (B) Textiles and Manufactures; (C) Ship-building and Sea Industries; (D) Machinery and Engineering; (E) Mining and Mineral Products; (F) Brewing and Distilling; (G) Paper, Printing, Bookbinding, &c.; (H) Scientific, Chemical, and Allied Industries; (J) Education and Science; (K) Furniture and Decoration; (L) Women's Industries and Cottage Industries; (M) Fine Arts; (N) Historical and Antiquarian. The profits of the Exhibition are to be given in aid of Irish technical and commercial schools. Lord Arthur Hill, M.P., is the honorary secretary.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 11.—"Recent Legislation concerning the Pollution of Air and Water." By ALFRED E. FLETCHER, Chief Inspector of Alkali, &c., Works. Sir FREDERICK ABEL, C.B., F.R.S., will preside.

APRIL 18.—"Telescopes for Stellar Photography." By Sir HOWARD GRUBB, F.R.S.

APRIL 25.—"The Physical Culture of Women." By Miss CHREIMAN. Sir DOUGLAS GALTON, K.C.B., F.R.S., Chairman of Council, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

APRIL 17.—"A Hundred Years' Progress in New South Wales." By W. F. BUCHANAN.

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

APRIL 24.—"Craftsman and Manufacturer." By LEWIS FOREMAN DAY. JOHN SPARKES, Principal of the National Art Training School, will preside.

MAY 8.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

MAY 29.—"Persian Textiles." By CECIL SMITH.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

APRIL 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. ROBERTSON, M.R.A.C.,

Principal, College of Agriculture, Madras. Sir JAMES CAIRD, K.C.B., will preside.

MAY 4.—"Caste." By Dr. G. W. Leitner.

The above dates are liable to alteration.

CANTOR LECTURES.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

LECTURE I.—APRIL 9.—Our Milk Supply.—Changes in town supply from various causes.—Agricultural depression, its effect in improving breed of cattle, and their food for milk production.—An agricultural department wanted to impart knowledge, to direct inquiry, and to stimulate practical education in dairy farming.—Milk not of uniform composition although containing the same constituents; a perfect food; composition of different kinds of milk; how preserved for ordinary use; cooling, its effect; why milk becomes sour.—Methods of milk examination; in the dairy, the depôt, and the laboratory.

LECTURE II.—APRIL 16.—Our Butter Supply.—Changes, as shown by imports and exports.—Butter imported in fresh or salt condition, according to position of country of production.—Home producer at a disadvantage; why?—Co-operation necessary; its working.—Letting cows, creameries, lump butter, central factories.—Milk for butter making; its treatment.—Sour and sweet cream.—Setting milk in shallow and deep pans.—The Schwartz, Cooley, and other systems.—Cream separators, centrifugal machines, De Laval's separator.—Churning, how done.—Different ways of making up butter for market.—The Danish, Swedish, Dutch, and French methods.—Improvement in English methods.—Butter, its composition; its adulteration and methods of detection.—Butter substitutes.—Margarine (butterine), how made.—Legislation.

LECTURE III.—APRIL 23.—Our Cheese Supply.—Increased imports.—Best milk for cheesemaking.—Coagulation of milk, treatment of the curd, ripening.—Home-made cheese, Cheddar, Gloucester, Cheshire, Derbyshire, North Wilts, and Stilton.—Foreign-made cheese, American, Dutch.—Fancy cheese, Cream, Gruyere, Gorgonzola, Roquefort.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Richard Bannister, "Milk Supply, and Butter and Cheese-making." (Lecture I.)

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. William Santo Crimp, "The Wimbledon Main Drainage and Sewage Disposal Works."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Dr. B. Derham, "The Errors and Defects of the Present Revenue System of Charging the Duty on Spirits, and the Means for Remedying Them."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. 1. Prof. Leitner, "Investigations on the Science of Language and of Ethnography." 2. Prof. Honeyman, "The Glacial Period on the East Coast of Canada."

TUESDAY, APRIL 10...Royal Institution, Albemarle-street, W., 3 p.m. Dr. Charles Waldstein, "John Ruskin." (Lecture I.)

Central Chamber of Agriculture (At the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Arthur Ayres, "Compressed Oil-Gas, and its Applications."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Sir Donald Currie, "South Africa."

WEDNESDAY, APRIL 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Alfred Fletcher, "Recent Legislation concerning the Pollution of Air and Water."

Geological, Burlington-house, W., 8 p.m. 1. Mr. W. Hill, "Lower Beds of the Upper Cretaceous Series in Lincolnshire and Yorkshire." 2. Dr. H. Hicks, "The Cae Gwyn Cave, North Wales."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Dr. R. H. Ward, "Fasoldt's Test Plates."

Pharmaceutical, 17, Bloomsbury-street, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Mr. E. Sidney Hartland, "Welsh Folk Medicine in the Middle Ages."

Civil and Mechanical Engineers, Town-hall, Westminster, S.W., 7 p.m. Mr. Walter Emden, "Theatres and other Public Buildings."

THURSDAY, APRIL 12...Royal, Burlington-house, W., 4½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture I.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. R. E. Crampton, "Central Station Lighting" (Transformers *v.* Accumulators).

Mathematical, 22, Albemarle-street, W., 8 p.m.

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, APRIL 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. R. Robertson, "The Experiences of Twenty Years in Conducting Agricultural Inquiries in Southern India."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Flower, "The Pigmy Races of Men."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, APRIL 14..Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Profs. W. E. Ayrton and Perry, "The Measurement of the E.M.F. of Dynamos." 2. Mr. W. E. Simpson, "The Variation of the Co-efficients of Induction." 3. Mr. C. V. Boys, "Some Experiments on Soap Bubbles." 4. Mr. C. D. Burton, "Electromotive Forces by Contact."

Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (With Vocal and Instrumental Illustrations.)

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FRIDAY, APRIL 13, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the fifth course of Cantor lectures on "Milk Supply and Butter and Cheesemaking," was delivered by Mr. R. Bannister, on Monday evening, 9th inst., the special subject of the lecture being the milk supply.

The lectures will be printed in the *Journal* during the autumn recess.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus. Doc. Oxon, at the House of the Society of Arts, and will commence on Thursday, the 24th May, 1888.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 11, 1888; Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bailey, George, 55, Gray-street, Blackfriars-road, S.E.
Beard, Edwin Thomas, Colonial College, Hollesley-bay, Suffolk.
Billing, Rev. Fred. A., LL.D., 7, St. Donatt's-road, Lewisham High-road, New Cross, S.E.
Bond, Robert Beaumont, Old Bank-house, Ipswich.
Boston, Henry George, Piccadilly, York.
Francis, William Henry, 5, Coleman-street, E.C.
Holme, George, Derwent-house, Milford, near Derby.
Hughes, Thomas, 44, Piccadilly, W.
Husni Bey, Lieutenant, The Gun Carriage Department, Royal Arsenal, Constantinople.
Joyce, Samuel, jun., 113, Richmond-road, Dalston, E.
Liddon, Rev. Henry Parry, D.D., D.C.L., Canon of St. Paul's, 3, Amen-corner, St. Paul's, E.C., and Christchurch, Oxford.
Sutton, Leonard, The Royal Seed Establishment Reading, Berks.
Woolf, Sidney, 7, King's Bench-walk, Temple, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Baker, Theodore, B.Sc., 35, Overcliff, Gravesend.
Bickersteth, Very Rev. Edward, D.D., Dean of Lichfield, The Deanery, Lichfield.
Ouseley, Rev. Sir Frederick A. Gore, Bart., M.A., Mus.Doc., LL.D., Canon of Hereford, St. Michael's, Tenbury, and The Close, Hereford.
Shields, Rev. John Samuel Sandys, D.D., Linden-villa, Westcombe-park-road, Blackheath, S.E.
Williams, John, 63, Warwick-gardens, Kensington, W.
Withers, James, 1, Culver-terrace, Sandown, Isle of Wight.

The paper read was—

THE PRESENT STATE OF THE LAW CONCERNING THE POLLUTION OF AIR AND WATER.

By Alfred E. Fletcher, F.C.S., F.I.C.,
H.M. Chief Inspector under the Alkali, &c., Works Regulation Act.

We all resent the interference of law; it comes as a restraint on our freedom. We prefer to think that our actions are so well regulated as to need no guidance from others. It would, indeed, be well if this were always so, but, unfortunately, the pressure of a present necessity, and a disproportionate view of self-interest, often distort the judgment, so that the constraint of law becomes necessary to prevent one man from trenching on the freedom of others while claiming to exercise his own. As men crowd more and more together, regulations as to possible pollution of air and of water become of the greater importance. The early settler in a new country, whose nearest neighbour is twenty miles away from him, may

do much in the way of polluting both air and water without injuring anyone. The fresh winds of heaven and the waters of the swiftly flowing river soon dissipate the impurity which he may have introduced. As population, however, increases, and when, as is the case in London, a mass of four million people is aggregated on the area of a small county; or when twenty large chemical works are crowded into the space of a square mile, whence the smoke and acid gases resulting from the combustion of 5,000 tons of coal are daily poured into the air; or where the banks of a stream are lined for many consecutive miles with dye and other works which discharge their dirty water into the once clear river; then indeed the balance is reversed. The land is small but the people are many, and it behoves every one to see that he sends away nothing into the air above him, nor into the water below, which shall interfere with the free use by his neighbour of these elements so essential to us all.

Unfortunately, however, we cannot help using, and to a certain extent using up and spoiling, these two essentials of our life, air and water. The manufacturer who carries on processes by which are produced some of the numberless articles which minister to our comfort, cannot wholly avoid sending into the air or the running stream some matter which is calculated to interfere with its purity. Therefore the law cannot step in, and with heavy hand put a stop to all such pollutions; it can only mitigate and set some limit to the evil, the existence of which it cannot but recognise.

It will be my object now to show what the law has done in this direction, and also to point out what may still be hoped for from its further action.

Firstly, as regards the pollution of the air.

In order to study well this portion of our subject, I must ask you, in imagination, to follow me into some of the more manufacturing districts of our country. We might visit some of the valleys in South Wales, where copper, zinc, lead, and iron, with silver, gold, and other metals are extracted from their ores. We should there see vast clouds of sulphurous acid, together with the oxides of arsenic, lead, zinc, and the more volatile metals, issuing from numberless chimneys and floating into the air; we should perceive the greasy odour of the hot oil of the tinplate works meeting us in the breeze, and the stinging smell of the patent fuel works, where those useful blocks of compressed coal are made which help to carry our ships across the seas. The streams of water have not escaped, they are no longer clear and bright as of yore, but are laden with a yellow stain, an ochry liquid from the tinplate works, caused by the acid rinsing of the plates, necessary for the removal of all tarnish before they are plunged into the melted tin.

You look from this to the hill sides, to the margins of the valleys where these various works are situated; these once were green and clothed with beech and drooping ash—now all is bleak and bare. No leaf stirs in the evening air; the underwood, the shrubs, the very grass is gone, and with the grass, the soil; for when the fibrous roots no longer hold it, the rain washes it down the steep slopes, and nothing remains but the bare rock or gravel; this latter not so trim and neat as the navvy would leave it, as on the side of yonder railway bank, but scored deep by the rain which, now unrestrained by root and fibre, or held back by the spongy soil, rushes down in torrents after every shower, scoring deep gullies in its downward course. Or we will visit a place or two in Lancashire where chemical works are found, perhaps twenty massed together in one spot, and some occupying as much as twenty acres of land. In more than one such manufacturing centre about 4,000 tons of coal are burnt in a day, yielding to the air no less than 120 tons of sulphurous acid every twenty-four hours. To this is added a certain amount of hydrochloric acid, nitrous acid, chlorine, and sulphuretted hydrogen, all of which, but for the firm repression of the law, would reach very large proportions. Here, too, the vegetation suffers greatly, the trees of the nearer land have disappeared, and all within a distance of three miles have suffered heavily, To give an illustration of the extent to which the principal of these chemical trades, the soda manufacture, is carried on, I may say, that at one of the places where it prevails, namely, at Widnes, in Lancashire, a waste product, called alkali waste, which is thrown out from the works, has accumulated within the last 25 years to such an extent that now 680 acres of land are covered with it, to a thickness varying from 8 to 25 feet, and amounting to about 9,000,000 tons. This material contains about 15 per cent. of sulphur, and, unless most carefully dealt with, is a constant source of sulphuretted hydrogen.

Or we might visit districts in Staffordshire, Yorkshire, Durham, or in Scotland, where the

iron manufacture is largely carried on in its various branches, and we should stand aghast at the sight of the vast volumes of dense and acid coal smoke that is thrown off, filling the landscape with its grimy haze. Doubtless we should be struck on observing a great irregularity as to this, and wonder that, if some manufacturers have done so much to restrict the emission of black smoke, others should have done so little.

Some districts in Scotland should also be visited, where a coaly shale is distilled in order to produce the paraffin oil we burn; there the peculiar odour that characterises the trade and a black acid smoke would arrest our attention, and there, too, we should notice the injury that has been done to the surrounding vegetation.

I will not take you further; enough has been shown to prove the great extent of air pollution which attends the larger manufacturing operations of our country; let us see what the law has done, and what it can do, to restrain, and if possible, to diminish it.

There was a time when men thought less of the products of such manufacturing work as we have been considering than they do now. They were satisfied with the produce of the farm, made up for their use by such hand labour as could be spared from the plough and the sickle. With bread to eat and homespun cloth to wear men were content. We now demand much more; our paper and our linen must be white, and for this purpose must be produced chlorine, a noxious gas, dangerous to both animal and vegetable life if allowed to escape. Our clothes must be dyed of various colours, the result of intricate chemical processes, during the conduct of which many noxious gases are evolved. We demand a liberal supply of iron, copper, tin, lead, and other metals; these must be extracted from their ores and purified by various smelting and other processes, during which, as has already been said, much destructive gas is thrown into the air. Indeed, almost all the good things we enjoy, the clothes we wear, the houses we live in, and much of the food we eat, are the outcome of some manufacturing process, during the progress of which smoke or vapour is discharged, to the detriment of the air we breathe. Shall we, then, stop all this work, and, clothed in skins and such rough garments as may have sufficed for our savage ancestors, at once gain repose and a clear atmosphere? Few, indeed, would counsel such a course; rather would we strive to elaborate as much as is possible from the materials nature has given us, striving the while to carry on our industry with such added skill as shall, as far as possible, diminish the evils liable to accompany it.

If we compare two manufacturers we may find a considerable difference in their methods of conducting the same process. Greater skill in the arrangement of apparatus, greater care in carrying on the work, a more thorough knowledge of the business in hand, will enable one more fully to prevent the escape of noxious gases, and in general to conduct his work so as to cause less nuisance than does his neighbour. Seeing this difference, the law has stepped in, and says that whatever can be done to prevent the escape of noxious gases must be done, and holds a man answerable for the result of negligence or ignorance. The law does not peremptorily forbid all escape of noxious gas, but it forbids under heavy penalties the escape of any which our present knowledge would enable us to retain.

The works first subject to legal enactment as regards the emission of noxious gases were those engaged in the soda manufacture. These works are not found distributed throughout the country, but they are collected in a few districts. The principal places are St. Helens and Widnes in Lancashire, Newcastle and the Tyne side, and Glasgow. There are also isolated works in East Lancashire and Yorkshire, near Birmingham and Bristol, and in North Wales.

Soda, in the various forms under which it is offered to commerce, is obtained from common salt. This substance is, in the first instance, decomposed by the action of sulphuric acid, hydrochloric acid gas being disengaged. In the earlier days of the manufacture, this acid gas was allowed to escape into the air, care being taken to pass it into a chimney with a good draught, in order that it might be carried away so as not to inconvenience the workpeople. From the chimney it descended on the country round, killing all trees and herbage within its reach.

Soon means were found for absorbing this gas in water, and thus arresting the escape of the hurtful vapour. This was effected with great care by some of the manufacturers, but less completely by others. It was at this point that the law stepped in. In 1863, the first Alkali Act was passed; it was enacted that all alkali manufacturers must condense at least 95 per cent. of their hydrochloric acid under the heavy penalty of £50 for the first, and £100 for a subsequent offence. To administer the Act, an inspector and sub-

inspectors were appointed, who had the right of entry to the works.

It may be said that in this the law made a great breach upon private rights; a man's house is his castle, and so is his factory, and who shall enter without his consent? True, but here we have an exceptional case. Usually the working of the common law is sufficient, and it is often said that for every wrong a man can suffer he has a legal remedy. On examination, however, it will be found that this case forms an exception to the general rule. As has already been stated, the chemical works referred to are found often in groups. This alone makes it difficult for a sufferer to single out that one from which he has received his injury. It may have been done by any one of them, or all may have contributed to produce it. Whom shall he sue for damages?

Let us imagine a group of chemical works, there may be twelve or twenty of them, from which acid vapours are either constantly or occasionally emitted. A farmer at a distance of half a mile finds his crops injured when the wind blows from the direction of the works on to his land. His oats or his wheat are growing well, they commence to flower, and all promises fairly for an abundant crop, when lo! a change of wind! the unwelcome "*chemic*" blows over him, and in a few hours he knows, by the sickly tinge of yellow widespread over the fields, that all hope of a plentiful crop is gone: the plants have been attacked at the most critical period of their growth, and if they survive at all the result will be disappointment, and the harvest a failure. Seeing this, he calculates the amount of damage he has sustained, and with the aid perhaps of a professional valuer, estimates in money the amount by which he will be the poorer for the injury the chemical vapours have done him. He goes now to the nearest of his chemical neighbours, and with samples of the damaged plants in his hand makes application for compensation. The manufacturer, on hearing his statement, expresses his sympathy with the farmer, and explains to him the careful arrangements he himself has made to prevent all escape of acid and hurtful gases from his works. He even takes the farmer round and shows him the clever apparatus whereby all such nuisances are rendered impossible. The farmer looks with rueful eye at his handful of withered plants, and holding them up as evidence asks, "Then how was all this done?" The reply is promptly given, to the effect that as the gas must have come from somewhere, and could not have come from these works, it probably proceeded from some of his less skilful or careful neighbours. The farmer's heart now fails him. He sees that this answer given by one will be repeated by all, and that it is impossible for him to discover who has done him the injury. Perhaps several have contributed towards it.

In the case here described the farmer is the sufferer; but the conditions may be reversed, and the careful and successful manufacturer may be placed in that position by the unfair application of the farmer.

As before, let us suppose a group of chemical works, but these very different from one another in their management, although the main processes carried on in them may be similar, in that gases are generated or dealt with which, if allowed to escape, would injure the neighbouring vegetation; yet in some of these works careful and enterprising men have brought the operations so much under control that no noxious gases escape, and no air pollution is caused by them. In a neighbouring factory, however, the managers and workmen are notoriously slovenly and careless, so that the place is a very fountain of impurity, a source from which injury may at any moment flow out over the country round. The farmer whose crops are damaged can, however, make no distinction. To him chemical works are all alike—places that he would willingly consign to oblivion. He, walking in his fields one evening, sees the smoke of the neighbouring factories pouring down his way, and calls his man to notice that the wind just then is bringing that of one of the more conspicuous works directly over his land. In the course of the night a slight shift of wind brings the smoke from another of the works across the field, and while that is so, a violent discharge of acid takes place. This injures the crops of growing corn, &c., so that in the morning the effect is plainly visible. The farmer now makes his claim against the chemical works first mentioned, the smoke from which he had noticed to be blowing over his land. He and his men saw the smoke advance from the chimney and sweep over his farm. In the morning he observed the fatal result on his growing crops. The evidence appears to be complete, and the farmer gains his case in court, obtaining heavy damages, the full anticipated value of his crop.

In this case the manufacturer was wronged; in the previous case, as described, the farmer

was wronged. How can justice be done between these conflicting interests? The common law evidently does not meet the difficulty.

Consider also another case. The proprietor of an ancient estate, handed down to him through many generations, resides in his baronial mansion, nestling in wooded hills and surrounded by a well-timbered park, the pride of the county. The neighbouring town becomes a centre of chemical activity, large factories are built, much sulphurous coal is burnt, and the impartial wind carries the acid smoke to the neighbouring park, where it soon makes its mark, shrivelling the leaves, destroying the topmost brances of the trees, working its way through the shrubberies, till tree after tree succumbs, and the ancestral mansion stands agape at the bare hillsides, till lately covered with stately oaks and branching elms.

The common law says that for every wrong there is a remedy, but what remedy can it give in a case such as this? To pay the proprietor the money value of his trees would be but to add an insult to the injury he has sustained in seeing his priceless acres denuded of their beauty. Even this money compensation would be hard to obtain in the case supposed where a large number of manufacturers and others have contributed to the damage.

In the cases now cited it is obvious the common law does not provide a remedy, hence the need of fresh legislation suited to the emergency.

Great doubt was felt as to how this new Alkali Act would work. A principle strange to British ideas was introduced. Could it be tolerated that an inspector should have the right of entrance to a man's premises by day and by night to ascertain what was going on? Doubtless the position was critical, and made great demand on the inspector's tact and wisdom. He had, however, this to support him: the foremost manufacturers were those who had done most to guard against the emission of noxious vapours, and they were not unwilling that this should be generally known. They also suspected that some of the neighbouring manufacturers were not as careful as they should be, and that they were suffering in part for their neighbours' sins. Thus the inspector found with the foremost manufacturers a welcome and general assistance in his work beyond that which might at first have been anticipated. He was regarded also as a valuable aid to the manager in maintaining the discipline of the factory, and an additional check on the accuracy of the work carried on.

It has long been known that substances which to-day are regarded as waste products before long find a use, and cases could be quoted where that which was once considered as useless has in time become the main product of a process. It may at first sight appear that, where a substance has a recognised value, there is no longer need for an inspector to enforce its retention, and, when it occurs in the form of a gas, to prevent its being allowed to escape into the air. Even in such a case there is, however, still a need for his action, for there is often a margin, an unbridged space, between the distance a man will go prompted by self-interest and the distance prompted by duty. The paths may lie in the same direction, but they are not always conterminous. Thus, to give an instance. By some mischance a bag of flour is brought into a room provided with a handsome carpet. It is upset, and spilt on the carpet. The owner of the flour proceeds to gather up his property, and, conscious of its value, leaves behind him as little of it as possible. He carries away all that he can conveniently collect, and is about to leave, when the owner of the carpet intervenes, and demands that a further process of removal shall be carried out—not now because of the value of the flour, but on account of the carpet, he demands that no trace of the white stain shall remain, that all shall be removed.

So it is with regard to the gas chlorine or hydrochloric acid, nitric acid and the like. These have all a commercial value, and no manufacturer could afford to allow them continually to escape; yet a sudden flaw or breach might occur in some part of an apparatus through which one or other of these gases may leak away. If the quantity of material thus lost were not excessive, it might be wiser, commercially speaking, to suffer for a time the loss than to stop the plant and repair it. Or, again, an apparatus is arranged for the condensation and arrest of hydrochloric acid gas, and is so far successful that nine-tenths of that generated is collected and made useful. But how about the remaining tenth? The manufacturer says that it will not pay him to put up increased plant to arrest this remainder; the amount caught will not be commensurate with the cost of catching it; it will be better for him to let it go. Here, then, the inspector steps in and puts on pressure, and obliges him

to go on further in the path he was travelling than he would voluntarily have gone.

Fortunately, men are generally rewarded for well doing, and the inspectors under the Alkali Act have often been thanked for insisting on improved methods of working, because in the end these have brought an unexpected benefit. Often have the inspectors been thanked by both masters and men for a change in a mode of operation, or in the construction of apparatus brought about by them, perhaps with considerable difficulty, and by the exercise of great moral pressure, extending even to the threat of legal action. One instance of this is so striking that I may be excused delaying a moment to give it. It is known to most that in the manufacture of bleaching powder chlorine gas is used in large quantities. It is made to flow through pipes into large chambers, on the floor of which lime has been spread. The lime absorbs the chlorine gas, and is thus converted into bleaching powder, every ton containing 7¼ cwt. of chlorine. It will be easily realised that, as the lime approaches saturation, the vigour with which it at first absorbed chlorine will diminish, and in the end it is likely that some of this gas will be left unabsorbed. In order now to pack the bleaching powder into casks, it is necessary that men should enter the chamber which has been till lately filled with chlorine; and that they may have air to breathe, and not be suffocated, the unabsorbed, the residual, chlorine must be removed. The easiest way of effecting this is to open the large doors of the chambers and allow the gas remaining in it to escape into the air. Many methods were suggested for preventing this source of nuisance, and dealing in some way with the residual chlorine referred to. The general feeling, however, was that the quantity was so small that it would not pay to deal further with it. Under the first Alkali Act, no power was given by which this state of things could be remedied, and the apathy remained. Under the more recent Alkali Act, which I will mention directly, power was given to control the emission of chlorine, and various methods were suggested by which the escape of this very noxious gas might be prevented, not for the sake of profit, but to avoid a nuisance. At length a method was perfected and adopted at one of the works. It was found to be so successful that not only was all the chlorine absorbed, but having the power of ending up the process when desired, the manufacturer found that he could work larger charges of material in the same apparatus in the same time. The result was that during the nine months following the adoption of the process referred to, 180 tons more bleaching powder were made than would otherwise have been the case, and the amount thus gained was £1,200. I bring this forward as an instance where a process was adopted under compulsion with a view to avoid a nuisance, but it ended in yielding a handsome reward. I may say, indeed, that results resembling this have followed constantly in the wake of improvements undertaken at the time with a view to prevent the escape of some noxious gas, but found ultimately to bring a reward with them.

The Alkali Act of 1863 introduced, as I have said, a new principle of legislation. By it power was given to anticipate, with a view to prevent an injurious action, the emission of a noxious gas, rather than to exact compensation for an injury committed. But this principle was introduced tentatively; it applied to one acid gas only, and to that gas only when it was produced in one specified chemical process—the muriatic acid gas of the alkali works. All other chemical works in the country, and all other processes from which noxious vapours might rise, were left untouched by the Act. In consequence of this limitation many curious anomalies arose. The muriatic acid generated in an alkali work must be condensed; if more than 5 per cent of that generated were allowed to escape, the manufacturer became liable to a fine of £50 for the first offence, and £100 for the second; but if from a neighbouring factory, not an alkali work, the same acid escaped, the Act was inoperative, for the inspector had no power to interfere; or if from an alkali work any other acid than hydrochloric acid escaped, the inspector then could not interfere. And even closer than this the line was drawn. The Act of 1863 spoke only of hydrochloric acid when generated in the process of the alkali manufacture, but other processes generating this acid might be, and sometimes were, carried on by the same manufacturer, and on the same premises with the alkali manufacture, so that hydrochloric acid from two sources might be passing along the same flue and issuing through the same chimney into the atmosphere. In such a case the inspector was actually obliged to estimate these separately. If, on testing the gases passing up the chimney, he found that an amount was escaping which exceeded the

limit prescribed in the Act, he had to go back to the flue bringing in hydrochloric acid from some process other than that of alkali making, and deduct that from the total he had first found; if then the residue exceeded in quantity the legal limit it was his duty to complain, but not otherwise. So we had legal and illegal hydrochloric acid. I fear that when such a mixture reached the farmers' crops or the neighbouring oaks no such difference was made, but the desolation inflicted was in proportion to the amount of acid, without distinction of origin.

With regard to all other acid gases, some of them equally injurious with hydrochloric acid, the first Alkali Act was silent, whether these gases proceeded from an alkali or other works. Still the principle had been introduced of empowering inspectors to enter the works uninvited, and without giving notice of their visit, in order to ascertain if the condensation of hydrochloric acid, as provided in the Act, was carried out.

The Act worked well; the inspectors' visits were not resented. Their business was to study one thing—the condensation of hydrochloric acid, and in this they became proficient. They could detect errors in the work that had escaped the eye of the foreman or manager less persistently directed towards them, their advice was sought in the erection of apparatus, and before long, under their influence, the forms of furnaces, condensers, and other appliances, were so much modified that the provisions of the Act were with very few exceptions habitually observed, and the statutory standard more than maintained. The standard in the Act was five per cent., but the amount of hydrochloric acid allowed to escape was reduced on the average to less than two per cent. Encouraged by this success, an amended Act was passed in 1874, which gave to the inspectors increased facility in controlling the escape of hydrochloric acid gas, and a modified power over some other gases from alkali works. The escape of hydrochloric acid had been limited to five per cent. of that generated; now a new method of measurement was introduced, the amount of acid escaping must also not exceed two-tenths of a grain in a cubic foot of the escaping air in chimney or flue.

Still the inspections were limited to alkali works; the gases or noxious vapours from all other sources were untouched.

To remedy this abnormal position, and to inquire into the subject generally, a Royal Commission was issued in 1876. Their inquiries extended over the whole kingdom, and a full report was issued in 1878. In this they recommended further legislation; and in 1881 the present Alkali, &c., Works Regulation Act became law. The main provisions in it which differ from those of the two preceding Acts are:—

1. The Act is made to apply to some other works than alkali works.

2. All noxious gases proceeding from alkali works are dealt with.

3. The principle is introduced of requiring that the best practicable method shall be employed in the repression of a nuisance.

4. An annual registration fee is chargeable on the owners of works.

The Act of 1881 is thus a great advance on those of 1863 and 1874, especially in that the principle is introduced of throwing on the manufacturer an obligation to employ the best known methods for preventing the escape of a noxious gas, or otherwise avoiding a nuisance. Where a fixed standard is to be adopted there is great difficulty in adjusting it. At first probably it is felt to be a sufficiently tight and repressive, but as improved methods of manufacture are introduced it becomes loose and far below the average standard actually reached—for instance, the standard of 0·20 grain per cubic foot as the limit of the amount of hydrochloric acid which may escape. For the last three years the quantity which actually escaped, as shown by the average of all the tests taken by all the inspectors throughout the country, has been 0·10 grain per cubic foot. The standard fixed as the limit of the amount of sulphuric acid escape is 4 grains in a cubic foot of air. The average amount actually escaping last year was 1·40 grain.

These standards, though felt to be sufficiently high at the time they were fixed, are now evidently much below those actually reached by manufacturers. An obligation, however, to adopt the best practicable method for the avoidance of a nuisance is an elastic band which is always tight, for it tightens with the increase of knowledge, and with the introduction of improved processes, a change which is always going on. Moreover, this is an obligation which no one can reasonably repudiate, as no one can object to be called on to do the best that can be done to shelter his neighbours from the injurious effects of his operations.

It may, however, be urged that this clause is not definite enough for the inspector. Who is

to say what is the best practicable method in a particular case? Fortunately, a direct answer to this question is not required. If in the case of sulphuric acid the inspector finds that a manufacturer habitually allows his exit gases to contain 20 grains acid per cubic foot, while the average amount is below $1\frac{1}{2}$ grain, it may safely be asserted that the best method for the condensation or retention of this acid has not been employed.

Moreover, the phrase not only goes beyond and is independent of definite fixed standards —it also constructs them. If it can be shown, after prolonged observation, that in conducting some process of manufacture a certain amount of success in controlling noxious emanations is usually achieved, this result becomes a basis for the future, a standard to which all are expected to conform; and this standard has the great advantage over one rigidly fixed by Act of Parliament, that it is one which accommodates itself to the varying conditions of manufacture and the changing light which knowledge brings to bear on it. In that the Act of 1881 embodies this principle, and enjoins in conducting certain manufacturing processes that the best practicable means shall be used for preventing the discharge into the atmosphere of all noxious gases evolved in such work, it makes a great advance over the past legislation on this subject.

Another point where the last Alkali Act made advance beyond those which had preceded it, is the increase in the number of manufacturing processes brought within its scope. The first Alkali Act touched alkali works only. In the last Act are included also those for the manufacture of sulphuric acid, chemical manure, nitric acid, sulphate and muriate of ammonia, chlorine, salt, and cement. The attempt, however, to enumerate those works which should be scheduled in such an Act as that now under our consideration can never be wholly successful. Scarcely is the ink dry with which such a list is written than works are established or processes are added to those already existing, which, had they been known sooner, would certainly have been included. As an instance of this might be given a process for preparing hydrate of strontia from the sulphate. This substance has lately been largely employed in the refining of sugar. In the course of its preparation the sulphide of strontium is decomposed, and torrents of sulphuretted hydrogen are set free. These might easily be retained, but the inspector has no power to interfere, although in a neighbouring works, where, perhaps, sulphate of ammonia is made, he complains if only a trace of that noxious gas is allowed to escape, and at once insists on a rectification of the apparatus.

Two courses might be indicated for overcoming the difficulty here pointed out. First, the list might be kept complete if powers were conferred on the Local Government Board to add from time to time the names of those works or processes which were found to emit such noxious gases as called for the kind of chemical inspection provided under the Alkali Act. Year by year the list would grow until every trade known to be noxious was included in it. Or a second method would be to cast off the limitation of an Alkali Act in favour of an Act for the repressing of noxious vapours generally. A list of these can be made out much more easily than can a list of the processes which produce them, and this list could be added to from time to time as the necessity occurred.

The first course involves the making and keeping complete a list of those processes of manufacture which are liable to produce noxious gases.

The second involves the enumeration of noxious gases found to arise from processes of manufacture or otherwise. A practical instance of the difference here pointed out can be shown by the following:—

The manufacture of sulphate of soda with evolution of hydrochloric acid gas is placed under inspection by the Alkali Act, and the escape of this gas into the air renders the manufacturer liable to heavy penalties; he therefore causes it to pass into a wash-tower or other apparatus, where, exposed to contact with water, it is dissolved, forming liquid hydrochloric acid. If now this acid is sold to a neighbouring manufacturer, who, for the purposes of his trade, exposes it to heat, and thus drives off much or even all of it into the air, he does not come within reach of the inspector under the Alkali Act.

A very common and similar case is that of nitric acid. The maker of this must conform to the provisions of the Alkali Act, but the purchaser of this same acid may use it in the solution of metals, or in any of the thousand ways in which this acid is employed, and in so doing drive off much of it, or of the lower oxides of nitrogen, into the air without coming under the restrictions of the Alkali Act. If, however, the act of discharging into the atmosphere any of the gases named were

forbidden, that would include the escape of the acid during its manufacture and also during its subsequent use.

It is clear that a standard or limit of condensation for all noxious gases arising from various sources and produced under varying conditions cannot be devised, and though the few standards that are embodied in the Alkali Act have done good service, yet in future it may be better to rest on the more general enactment already referred to, which was first introduced in the Amended Alkali Act of 1874, and repeated in that of 1881, that "the owner of any works shall use the best practicable means for preventing the discharge into the atmosphere of all noxious gases, and of all offensive gases evolved in such works."

Although this clause embodies no fixed standard by which to determine the amount of noxious vapour which may be allowed to pass into the air without its being considered a violation of the Act, yet, after a short time, standards would adjust themselves. After repeatedly ascertaining in various works throughout the country the extent to which a noxious gas produced during the working of a certain process can be arrested, and how much still escapes when the best appliances are employed, a standard grows up and is understood by both manufacturer and inspector to be the amount beyond which no escape can be permitted. In the public report presented annually to the Local Government Board by the chief inspector, the average results of inspection, and the standards adopted are published, and thus become definitely known. They are better than any standard fixed by Act of Parliament, because they are ever advancing according as our knowledge increases, and improved methods of manufacture are adopted.

It is now twenty-five years since the first Alkali Act was passed. At first only alkali works, those engaged in the soda manufacture, were included; of these there were 85 in the year 1864; these subsequently increased to the number of 150. The country, including Scotland and Ireland, was divided into four districts; each was placed in charge of an inspector, and the whole was superintended by a chief inspector, the late Dr. R. Angus Smith. At first the manufacturers were in doubt as to how their new visitors were to be received. Did they come as friends or foes? I remember my first introduction when, in 1864, I entered on my duties as Inspector of the North-Western district. It was at a large alkali work in Lancashire. I was brought into the chemical laboratory, and stood surrounded by a small group of chemists and managers. The principal manager then introduced me as "the gentleman who had come down from London to teach them their business." After the lapse of twenty-four years one can afford to smile at what was not over-pleasant at the time, and those who are familiar with Lancashire men will appreciate the cutting sarcasm which saturated that little speech. I must say, however—and in this I know I shall be borne out by my colleagues—that the large manufacturers with whom we had to deal were ever open and candid with us. They knew we had our duty to perform, and they placed no hindrance in our way; on the other hand, they soon found that our continual testing the gases passing away from their processes was a means of helping them to improve their system of working, and to introduce many economies of the possibility of which they had till then been ignorant. Very great changes were gradually introduced; the means of condensing and arresting the escape of acid gases were improved until the standard fixed by the Act for the condensation of hydrochloric acid was soon left behind, and was only approached in cases of accident or exceptional carelessness. So much did manufacturers vie with one another to keep well within the limits laid down by the Act that very few prosecutions took place; they were only found necessary in quite exceptional cases. Indeed, the landed proprietors complained that the Act was not efficiently administered, or there would have been more prosecutions. Those, however, on whom the responsibility rested, felt that the main object of the Act was not to multiply prosecutions but to keep down the amount of acid and destructive gases liable to escape. That this was only to be done by instituting a system of reform in the methods of working and the construction of apparatus, by carrying out, indeed, a system of education which could not be the work of a day.

Remembering now the continued effort that has been during so many years put forth, it is satisfactory to know that if we did not go "to teach them their business," we have at least been able to help them to increase their knowledge of it, thus benefiting them while we protected our clients the farmers.

As showing the feeling that has grown up between the manufacturers and the inspectors, I will quote the words of Mr. A. M. Chance,

the well known and influential chemical manufacturer, at Oldbury, Staffordshire. They occurred in a paper read by him in 1883 before the Birmingham Philosophical Society. He says:—

"In my opinion Government inspection has not only led to material improvement in the general management of chemical works, but it has also been in reality a distinct benefit to, rather than a tax upon, the owners of such works; and so long as gentlemen of high scientific attainments continue to be appointed, who are thus capable of assisting manufacturers in their endeavours to improve their processes, Government inspectors ought to be regarded by the owners of inspected works in the light of friends."

Up to the end of 1881, alkali works only were under inspection, then the area was increased, and various other chemical trades were brought within the scope of the new Act. The number of works now under inspection is 1,060. The country is divided into seven districts, in which are nine inspectors and sub-inspectors. There is also a chief inspector. During the last few years the duty of the inspectors has been very heavy. The smaller chemical works scattered through the country are not always carried on with the same skill and scientific management as is the case with the larger alkali works, and much effort has been necessary to bring them into conformity with the provisions of the Act. Much of this difficulty has now been overcome, and it is hoped that the work will become lighter.

I have hitherto spoken of the legislation which affects that class of air pollution which may be called chemical; that which arises from the gases thrown off from chemical works, chiefly acid gases. There are, however, many sources of air pollution, especially those which arise from decomposing animal and vegetable matter, from drains, from such trades as fish driers, blood boilers, horse slaughterers, tanners, and the like. The law concerning such is contained in the Public Health Act of 1875, Section 114. The law is administered by the local sanitary authority, who can be moved to action by the medical officer of health, two medical practitioners, or by ten inhabitants of the district. Fines may be imposed ranging from £2 to £200. In order to cope with the air pollution which may proceed from noxious trades such as those just mentioned, no scientific inspection is necessary, the human nose is a sufficiently accurate instrument of investigation, and they may safely be left to the local sanitary inspector.

Hitherto I have made no mention of that great and widespread source of air pollution, common coal smoke. It is the most extensive and the most ancient source of it; the amount of the injury it does us can never be told. It has a twofold sting; in the first place it spreads a gloom over our towns, providing a constant supply of dirt of a kind that insinuates itself everywhere; and secondly, it fills the air with an acid gas, injurious alike to animal and vegetable health, and destroys metal-work and the solid masonry of our buildings. From its earliest appearance it has been decried as a nuisance, laws have been levelled against it, yet it still holds its own in spite of king or Parliament.

In the year A.D. 1316, Parliament presented a petition to King Edward II., praying that he would issue his royal proclamation to forbid the use of coal in London, and thus put a stop to the new nuisance then already much complained of. Till now wood had been the only fuel; as the population, however, increased, the forests were cleared and it became less plentiful. Coal, reached at first without much mining effort, was used in its place, and shortly before the date mentioned ships freighted from Newcastle with the now familiar mineral reached London. There, used as a fuel in manufacturing operations, it made its presence known by the black smoke it produced, pretty much as it does at present. Disgusted with this defilement of the then smokeless air of London, the citizens cried out against it, and we learn that a proclamation was issued forbidding its use.

Necessity, however, knows no law, and leaps over even a royal proclamation. In a few years the scarcity of wood as fuel becoming even more felt, while the economy and the efficiency of the new, though smoky, fuel was more and more acknowledged, it crept again into use, and the prohibition ceased to be held binding. For a long time London, mainly on account of its size, was the most smoky city in the kingdom, but in recent times, since the more general application of steam power to the various manufacturing processes of the country, many northern towns, some even of moderate size, have quite carried off the palm from the metropolis for smoky blackness. If any Londoner doubt it, I would advise a visit to some of the mills in Lancashire and large manufacturing works in the Midland counties, to the neighbourhood of Middlesborough-on-

Tees, and of many towns in Scotland; and, if last, not least in sooty shadow, the otherwise beautiful Clyde itself, and the lovely lochs which open on the Frith, all made dismal and grimy by the belching forth from steamboat funnels of pitchy gases, which missing the proper moment of burning, to add heat to the boiler, rush out in such filthy volume as to obscure the landscape and paint the heather-decked hillsides and the blue sea one dismal hue.

All will acknowledge this to be a nuisance, and all engineers will admit that it is curable. On this point I myself claim to speak with authority as an engineer and as a chemist, and I say decidedly that in nearly all cases the sending out of back coal smoke may be avoided. To support this I could bring testimony in abundance, and I have done this sufficiently in my reports under the Alkali Act for the years 1885 and 1886.

In 1819, a Select Committee of the House of Commons was appointed, to inquire how far persons using steam-engines and furnaces could erect them in a manner less prejudicial to public health and comfort. The committee reported that, "so far as they have hitherto proceeded, they confidently hoped that the nuisance, so universally and so justly complained of, might at least be considerably diminished, if not altogether removed." In 1843, another Select Committee "inquired into the means and expediency of preventing the nuisance of smoke arising from fires at furnaces." They concluded by recommending "that a Bill should be brought into Parliament to prohibit the production of smoke from furnaces and steam-engines."

The legislation which has followed is not as trenchant as that of Edward II., to which I have already alluded. He decreed that since, on burning coal, smoke was emitted, the use of coal must cease. Our law is not quite so violent. In the Public Health Act, 1875, it is decreed that black coal-smoke is a nuisance, and those who cause its emission are indictable by summary procedure. The enforcement of the law is in the hands of the local sanitary authority, and Section 92 declares it to be their duty "to enforce the provisions of any Act in force within their district requiring fireplaces and furnaces to consume their own smoke." To this, however, there is a saving clause in favour of furnaces for the smelting of ores, or for calcining, puddling, or rolling of iron. This weakens the Act very much, but a more radical source of weakness is that the administration of the Act is in the hands of the local sanitary authority. As the manufacturers, the smoke producers of the district, are usually well represented on the Local Board, it is not to be wondered at that the smoke prevention clauses are not very strictly enforced.

For London, a special Act was passed in 1853, the Metropolitan Smoke Nuisance Abatement Act. The working of this is in the hands of the Commissioners of Police, and a very great improvement was effected in the manufacturing districts of the town. A marked improvement was observed in the small steamboats which ply above London-bridge as soon as this, the so-called Lord Palmerston's Smoke Act came into force. It was wonderful how much smoke so small a boat could make, now all are smokeless, and the benefit was felt at once. Among signs of this is the changed aspect of the Temple-gardens, which abut on the river. Now flowers and delicate plants flourish there during the summer months, showing as gay a sight as can be witnessed in any country town, while before the passing of the Act all was dismal and smoke polluted.

The Act of 1853 was followed by another in 1856, which repealed the saving clauses in the former Act in favour of potteries and glass works. It also extended the scope of the Act to all steamboats plying west of the Nore, and to the furnaces of public baths and washhouses.

It seems clear that the Smoke Abatement Act is more operative in the metropolis than elsewhere, because it is there administered by an authority independent of the locality. Doubtless also the success which has attended the working of the Alkali Act has, in part, arisen from the fact that the inspectors under it have been dependent on a central authority and not on a local one.

In all there have been 14 Acts of Parliament in which the emission of black smoke is prohibited. Nine of these are for England and Ireland, and five for Scotland. They are

1845....	8 & 9 Vict.,	c. 20,	s. 114
1845....	8 & 9 Vict.,	c. 33,	s. 107
1847....	10 & 11 Vict.,	c. 34,	s. 108
1852....	16 & 17 Vict.,	c. 128,	ss. 2-6
1856....	19 & 20 Vict.,	c. 107,	s. 1
1866....	29 & 30 Vict.,	c. 90,	s. 19
1868....	31 & 32 Vict.,	c. 119,	s. 19
1875....	38 & 39 Vict.,	c. 55,	s. 91
1878....	41 & 42 Vict.,	c. 52,	s. 107

Acts for Scotland.

1857	....	20 & 21 Vict., c. 73
1861	....	24 & 25 Vict., c. 17
1865	....	28 & 29 Vict., c. 102
1867	....	30 & 31 Vict., c. 101

It cannot be doubted that further advance in the direction of smoke abatement awaits the impulse of public opinion. In almost every case the emission of black smoke from furnaces may be much diminished, or entirely suppressed, and if the administration of the law were placed in the hands of officers independent of the local influence, a rapid change for the better would be speedily brought about.

I have not now time to describe the many appliances that have been found successful in preventing the emission of black smoke, but I will briefly refer to two prospects opening to us whereby the combustion of coal will, at a future day, be carried on in such a manner as to preclude the possibility of causing smoke. I refer to Mr. Mond's new gas producer, and to Mr. Hargreaves' new thermo-motor. In the case of the gas producer, all the coal is transformed into a gas consisting chiefly of hydrogen and carbonic oxide, a mixture incapable of depositing soot. In producing the gas, a much larger quantity of ammonia is collected than has formerly been done, making the conversion into gas an economical process. The great convenience which attends the use of gaseous fuel, together with the gain in ammonia, will probably cause an extended application of this arrangement, and will so far remove all possibility of black smoke being produced.

The second avenue of hope is opened by Mr. Hargreaves' thermo-motor. Here the steam boiler is done away with, and the combustion is carried on by the admission of small quantities of fuel at a time into the furnace under pressure, in such fashion that the combustion is too perfect to admit of the formation of smoke. The duty obtained from the fuel in this motor is three times that of the best steam-engines, and bids fair to supersede them.

Although it is pleasant to see hope looming in the distance from these two sources, yet it is to be hoped that we shall not have to wait for their full development before black smoke is suppressed by a more vigorous administration of the law in favour of light and pure air.

Hitherto I have spoken only of smoke from factory chimneys, but in London and other large residential centres we suffer mainly from that of the domestic hearth. There are great difficulties in the way of removing this source of smoke, but much may be done to diminish it. Of this I speak from personal experience, having so arranged the heating arrangements of my house that I contribute no smoke whatever to the air of the town, and but a tenth part of the sulphurous acid gas which my neighbours send forth.

It is unnecessary here to describe my method, as I have done recently in a paper read to the National Smoke Abatement Association. I may, however, say shortly that the system I have found satisfactory consists in placing a hot-air stove, heated by coke or anthracite, in the basement of the house, and by its means sending a liberal stream of warm air day and night into the hall, or, if preferred, into the several apartments. This warms the house throughout so thoroughly that it has the effect of a change of climate upon the inmates; it is like a change from January to May. The large and constant open fires become unnecessary, and small gas fires may take their place, being required more for the sake of appearance than for heat. The cooking and water-heating are done by gas. The system is strongly to be recommended on the score of comfort, health, and economy. Less dust is found in the house, and no smoke is discharged outside.

Pollution of Water.

Very much that has been said with regard to the pollution of the air applies also to the pollution of water. That water must be largely used in many manufacturing processes is evident, as instance dye works, paper works, print works, chemical works, and the like. The required water is drawn from the neighbouring stream and returned to it again. The public are right in demanding that it shall be so returned in as pure a condition as is practicable, in short, to borrow the words of the Alkali Act, they demand that the "best practicable and reasonably available means" shall be used for rendering the effluent liquor from their works pure and harmless.

In order to enforce this, the Rivers' Pollution Prevention Act, 1876, was framed. The Act remains very much in abeyance for the same reason that the Smoke Acts have been so inoperative, namely, that it also is left in the hands of the local sanitary authorities. No inspector is appointed to enforce the Act, though, strangely, an inspector is called in to

stop the working of the Act. Under Clause 12 an inspector is empowered to give a user of water a certificate to the effect that he has used the "best and only practicable and available means" for rendering harmless the liquors he is allowing to flow into the river. A certificate hard to give at any time, but, strange to say, after having given it the inspector has no power to enforce the continued carrying out of the "best and only practicable" means for the use of which he has certified. Yet the certificate holds good for two years, and may be produced in any court as evidence for the manufacturer. If this clause were repealed, and inspectors were appointed to enforce the Act, as in the case of the Alkali Act, there is little doubt that in time our rivers would resume much of their ancient beauty, and we should hear of the saving effected in utilising materials formerly allowed to flow into the stream. Before long the inspectors would be received by the manufacturers as their friends and helpers, as is now the case with the inspectors under the Alkali Act. They would feel indebted to them for their careful watch on the effluent waters of their factories, thus saving much of the loss to which they had been previously subject.

DISCUSSION.

Mr. Robert Manuel said, in the earlier part of the paper reference was made to the Common Law aspect of the case, but he rather thought that the lecturer was not quite accurate in the inference which he drew. Mr. Fletcher said there was a legal maxim, *Ubi jus ibi remedium*, which, freely translated, meant, where there is a right there is a remedy, but he (Mr. Manuel) thought that was a popular though not a scientific view; it should be translated—where there is a legal right there is a legal remedy. Another well-known legal maxim, which was pertinent to the consideration of this subject, was, *sic utere tuo ut alieno ne lædas*, which translated meant—so use your own as not to injure that of others. Now, he would deal with the hypothetical case of the farmer who went to a group of alkali manufacturers and complained that his crops had been injured, but he could not identify the individual who had injured them. There was a case recently decided in the Chancery Division, which related to a riparian interest, and was on all fours with the hypothetical case put by Mr. Fletcher. In that case a riparian occupier was injured by some proceedings of other riparian owners higher up the stream; he brought an action against them, asking for an injunction to restrain the pollution of the stream, and the defence of the particular manufacturers was, that they might infinitesimally injure the stream, but it was a group of manufacturers doing that, and that, therefore, they were not responsible. Notwithstanding that defence, the Court decided against them, holding that, though the damage might be infinitesimal, still they were liable.

Mr. C. G. Cresswell recollected, about ten years ago, when at Runcorn, a case, which probably Mr. Fletcher had in his mind, viz., the action brought by Sir Richard Brooke against Messrs. Wigg Bros. and Steele, for destroying his park. It was true that Messrs. Wigg's were the nearest works to Sir Richard Brooke's property, but having regard to the relative position of Widnes generally, and Sir Richard Brooke's property, it was the opinion of the world in general, and certainly of the manufacturers, that Wigg Bros. were hardly dealt with. They were cast in heavy damages, and at the same time the feeling was, that the other Widnes works were equally to blame. As regarded the question of condensation of hydrochloric acid, there was no doubt the enormously increased value of that acid had added a stimulus to all manufacturers to save it so far as possible. Hydrochloric acid was now the main object of the Le Blanc process. In 1881, the late Mr. Weldon read a paper describing the change which was in progress, and this change had since taken place. It was a most ominous matter, for unless the price of chlorine kept up, the manufacture of soda by the Le Blanc process would very probably come to an end in due course. He thought glass works ought to be included in the operation of the Act, as they used a large quantity of sulphate of soda, not carbonate of soda, as in olden times. In the furnaces all sulphate was decomposed into sulphide, and re-decomposed by the silica present. Considering that the operations were carried on on the largest possible scale, the injury done by glass works was very great. He thought other manufacturers would prefer the Act being somewhat extended, because every man who was inspected must feel it hard that there were other men who had done as much damage as he did, who were not reached in any way. As regarded coal smoke, he was discussing the point as to its prevention the other day, with two or three manufacturers in London, men who were sufficiently eminent to make them perfectly impartial in the matter. One of these gentlemen reminded him of a curious thing which he had noticed, viz., that sulphurous acid gas on being liberated, and coming into contact with moist air, precipitated it in the form of fog. Combustion of coal, however perfect, would therefore still cause London fog, though it might not be of quite so deep a tint as at present. One objection to the black fogs of London was the oily matter associated with them, which coated over each globule of vapour, and rendered them more difficult to disperse. With regard

to the pollution of water there were two points. The adoption of the new processes for the recovery of sulphur from alkali waste, however operative they might be, would not get rid of the present heaps of alkali waste, from which there was a large quantity of drainage, and must be for years. When he was at Oldbury, at the works of Mr. Chance, they adopted a process for treating this drainage invented by M. Pechiney, of Salindres. The drainage from the alkali heaps was collected in a large vessel, and oxidised by means of a Körting's blower until a test showed that sulphuretted hydrogen was not given off on addition of acid. When it was sufficiently oxidised, the acid was added, and the whole of the sulphur present in the liquor was thrown down in the shape of commercial sulphur. That struck him as a means which might be generally adopted in alkali works. Another new machine which had lately come under his notice, dealt with other classes of pollution, notably those from paper works. Many excellent evaporators had been invented, but there was an American invention, known as the "Yaryan," which acted by means of a progressive vacuum in a series of vessels. The vessel in which there was the least vacuum was heated to a high temperature, and that with the greater vacuum was heated at a low temperature, and it was claimed that the cost of evaporation was vastly less than by any other process.

Mr. Albert E. Reed remarked that English manufacturers had to compete with foreign manufacturers, who were largely aided by their Governments, and he thought that manufacturers should be told by inspectors what would be the best practical methods for the prevention of pollution. Inspectors told manufacturers that they were polluting air and water, and were not using the best practical methods for preventing this, but they did not tell them what were the best methods. He considered that the administration of the Acts should be entrusted to responsible gentlemen who understood what should be done, in the same way as was done with alkali works, so that all manufacturers might stand on the same footing. With reference to the Yaryan evaporator, he considered that great results would accrue from the use of that apparatus. But supposing a manufacturer had expended several thousand pounds in putting up an evaporator, and some improved method was invented, it was rather hard that he should be called upon to throw away the money he had already spent.

Mr. Fletcher said, with regard to the legal aspects of the question, he thought, Mr. Manuel had taken an instance which was not exactly parallel with the one at issue. In the case of the farmer, he found his crops injured by one, or all of a group of works; the injury was done at night, when no trace was left, so that he had no means of finding out the aggressor; but in the case of fouling a stream, the person aggrieved could act as his own inspector and trace out the source of injury. It had been suggested that a person might sue when there was an infinitesimal contribution to a general nuisance, and this might be correct in theory, but it could not be carried out in London, where everyone contributed to the nuisance. Of course this was an exaggerated case, but it was an instance of how helpless were the inspectors. He had attempted to show in his paper why inspectors were necessary, and it was in this belief the Act was passed, and they were appointed. With regard to river pollution, there was no doubt that paper works sent a large qnantity of weak liquor into the river which commercially was useless, but if an economical way of evaporating it could be devised, the impurity of the rivers would be a thing of the past. The Yaryan process was an economical one. Mr. Reed objected that the best practical method would be hurtful sometimes, as it would not be economical, but the "best" included the most economical. To oblige a man to put his works under a glass case in order to avoid polluting the atmosphere would be a theoretical way of preventing it, but it would not be the best, because it would be an impossible way. To attempt too great a refinement would be to fail altogether. The word "best" carried with it all conditions which had to be observed. It was no use advising a process which was not economical, as it could not be carried out.

Mr. W. Smartt said, that having been on a sanitary committee, he had watched the working of the Act of 1875, and from what he had seen lately, he came to the conclusion that the management of local authorities was not efficient; and he considered that surveyors who were employed by the local authorities ought, if possible, to receive some kind of training at a central authority.

The Chairman said they had had a most interesting paper, for which they were much indebted to Mr. Fletcher, and they were specially indebted to men like him, who gave a conscientious and enlightened account of their official labours. All those who had looked into the way in which the legislation with regard to alkali, and kindred works was carried out, must agree that there was no better illustration of the benefits resultiug from the application of science in its bearings upon the welfare of communities and the advancement of industries, than that afforded by the administration of the Alkali Acts. The first Act was necessarily tentative in its character. It was important to make a beginning in the direction of endeavouring to exercise control over emanations that were allowed to pass into the air from chemical works. A very small amount of good was expected to be effected in the first instance, but with the rudimentary Act of 1863 important work was already done, and this was primarily due to the sagacious, prudent, and judicious manner in which it

was administered by those to whom the work was entrusted. No better man could have been selected as the first chief inspector of alkali works than Dr. Angus Smith, and no better first lieutenant than Mr. Fletcher. Dr. Angus Smith combined with great sagacity, scientific knowledge, and power of applying that knowledge to practical purposes, great amiability of character and tact; he saw the difficult position in which he and his colleagues were placed in endeavouring to administer a new description of what appeared to be inquisitorial legislation, and he set to work in the first instance to make friends with those who thought him their enemy. Those who knew the results achieved by Dr. Angus Smith and his colleagues during the first years of the working of the Act of 1863, could bear testimony to the success which attended their efforts to enlist the interest of chemical manufacturers in the working of the Act. Mr. Fletcher had pointed out how in the first instance the inspectors were regarded with a jealous eye, but afterwards it was found that, although they might not be technical chemists, they could materially assist manufacturers in exercising control over their works; not by prying into the special knowledge of each individual manufacturer, but by studying broadly the processes which they were to supervise; they were able here and there to suggest improvements in, or methods for dealing with escapes of noxious vapours, which otherwise might have been allowed to continue in their original condition for an indefinite time. When the Royal Commission of 1868 came to investigate what had been done, they felt it was obvious that much more ought to be accomplished, and, as a result, the Acts of 1874 and 1881 were passed. These Acts included other works, and the important addition to legislation was made of compelling or bringing manufacturers to use the best known means of working, with a special view of preventing the escape of noxious emanations. Having been a member of that Royal Commission, he was struck with the manner in which the inspectors had done their duty. Cases were discovered where it at first appeared as though prosecutions might, with advantage, have been undertaken, but on closer examination, the Royal Commission gave Dr. Angus Smith and his colleagues full credit for the prudence with which they had proceeded in endeavouring rather to lead manufacturers to see their faults, and to adopt by advice and expostulation, better processes, than by applying the vigorous hand of the law, and thus bringing opposition to bear upon the Act, which they could very easily have done, whereby improvement would have been greatly retarded. With regard to river pollution and smoke-abatement, and whether the law might not be better administered, he would not touch upon these subjects further than to say that if the law could be as judiciously administered as it was in the case of alkali and other chemical works, they might expect more beneficial results than had been attained up to the present time. In conclusion, he begged to propose a hearty vote of thanks to Mr Fletcher for his interesting paper.

The resolution was passed unanimously, and the meeting adjourned.

Correspondence.

SCIENCE AND ART DEPARTMENT.

It would be obviously impossible for me to accept Professor Silvanus Thompson's challenge to discuss the various objections which he urges to the rules of the Department from those which "boycott free education," as he phrases it, downwards. But there are one or two matters of fact which I think I ought to notice, and then, as far as I am concerned, this correspondence must cease.

Professor Thompson particularly requests me to contradict him if he is wrong in stating that "the fact," which he gives as an illustration of the rules with regard to the qualifications of teachers generally, "of having learned building construction in a builder's or architect's office is not recognised as any qualification." As a matter of fact the Department has, in numerous cases, dispensed with examination, when the applicant could show that he was possessed of special qualification. But what difficulty can there be to a man who has properly learned building construction, or any thing else, anywhere, passing the examination of the Department and thus obtaining in the regular way at least the minimum qualification requisite to enable the school in which he teaches to receive payments on the results of his instruction?

Professor Thompson thinks this minimum qualification too low. But surely this is an easy way to "allow specialists who have the technical knowledge to be chosen by the local committees," even though it be not "irrespective of their fulfilling the present arbitrary qualifications." Perhaps if Professor Thompson looks at the matter in this light he may "freely admit that the bottom is knocked out of much of what he has said," especially if he remembers that the teachers are under the local committees to whom all grants are made.

It is quite true that, *except under special circumstances*, the payment of fees for instruction by the students is a necessary condition of grants to the school. But I should like to know the name "of a certain large town in the North of England where there exists an extensive local voluntary organisation for carrying out free science classes. Its work, excellent, as I can bear witness, is, by this clause, put out of recognition: its teachers cannot receive the grants, nor the pupils the prizes offered by the Department to those who may pass the Department's examination," before I can admit that he has not

been misinformed as to grants. In any case it is not a fact that the pupils of a free school are thereby debarred from prizes.

J. F. D. DONNELLY.

11th April, 1888.

UNIFORMITY IN SHORTHAND.

A letter on this subject, in the *Journal* of 30th March, calls for a few lines of reply. Mr. W. Storr says, with regard to the recent memorials from the Reporters' Gallery against monopoly in shorthand, that "some" declined to sign the memorials; two gentlemen declined to sign them, Mr. Storr being one, while ninety-four signed them readily. I cannot really accept Mr. Storr's kind explanation that "there were some who signed them without much reflection to oblige the amiable gentleman by whom they were presented." The point at issue was one which admitted of being stated in very few words, and it was so stated, and attention was called to the memorials generally, and to the most important paragraphs particularly, before the signatures were appended. Very many of the signatories had opinions on the subject as well-defined as my own; others agreed perfectly with the object of the memorials on its being brought before them; in short no memorials were ever more intelligently signed—as one would expect to be the case, seeing that those who signed were members of the Reporters' Gallery; and the two signatures refused were withheld with equal intelligence.

On the larger subjects which Mr. Storr opens, I do not think it worth while to follow him in detail. The use of shorthand copy on the press, to be read by compositors, is being constantly urged by Mr. Pitman. I think it is obvious that Mr. Pitman's knowledge of the modern press is not sufficient to constitute him a safe guide in this matter. Even in the case of Mr. Storr, I suspect that his acquaintance with the working of the composing-room and the sub-editing departments of a daily newspaper is less thorough than it should be, to give his advice the value which, on other than practical grounds, it certainly possesses. Strange to say, neither Mr. Pitman nor Mr. Storr advocates the use of shorthand copy in book-publishing houses, where, from the greater regularity and leisure, the plan is much more feasible than on the daily press. The thin end of the wedge goes first. When authors write their works in shorthand, perhaps printers may be induced or compelled to learn to read it. As to the use of shorthand in commercial life and book-keeping, I have nothing more to say than that, as no employer will allow his affairs to pass out of his own knowledge, it seems more necessary to insist upon employers than upon the employed learning the art.

The question of comparative legibility is really important. As between the two systems mentioned by Mr. Storr—Gurney's and Pitman's—there can, I should suppose, be no question that Gurney's is far the more legible of the two. But, surely Taylor's is entitled to mention. It should be borne in mind, too, that there are now several new systems, each founded on its own special principle, in which legibility is especially considered; and I think I may say with confidence, that each of the authors I refer to holds that Mr. Pitman's system has the smallest margin of legibility of all the competing methods. The public has an interest in no one system being established or endowed. My own belief—and a very strong belief—is, that it is not shorthand which will be substituted for longhand writing on the press, but type-writing. The type-writer, which is easily learnt, which doubles the power of the pen, and which provides the best of all "copy" for printers, is, I think, manifestly destined to take the place on the press, and probably in many other departments of activity, which Mr. Pitman and Mr. Storr imagine to be reserved for phonography.

A. JANES.

5, Crofton-road, Camberwell, S.E.

Notes on Books.

WATTS'S DICTIONARY OF CHEMISTRY, revised and entirely rewritten by H. Forster Morley and M. M. Pattison Muir. Vol. 1. Longmans, Green and Co. 1888.

It is now five and twenty years since the first edition of "Watts's Dictionary of Chemistry" was commenced. The work was completed in five volumes, and three supplements followed. The second part of the last of these appeared seven years ago. A new edition of this important work has therefore been looked for, and the first volume has just been published. The work is to be brought within the compass of four volumes, of about 750 pages each. It is printed in double columns, and a larger page than that of the original edition has been selected, so that a much greater amount of matter is got into each page. Some condensation, however, has been necessary in order to bring the materials into the space at the disposal of the editors. The title of the original edition is "A Dictionary of Chemistry, and the Allied Branches of other Sciences," but the new edition deals with Chemistry alone. No special information on the processes of chemical technology is given in this edition, as it is proposed to publish a companion volume on technical chemistry, edited by Professor Thorpe. Dr. Morley is responsible for the articles on organic chemistry, and Mr. Pattison Muir for those on inorganic and general chemistry, and the editors have been assisted by many English, American, and foreign contributors to the dictionary. This first volume concludes with an article on chemical change.

Modern Theories of Chemistry. By Dr. Lothair Meyer. Translated from the German by P. Phillips Bedson, D.Sc.Lond., &c., and W. Carleton Williams, B.Sc., &c. London: Longmans, Green and Co. 1888.

This learned volume, which Professors Bedson and Williams introduce to their countrymen, treats of the highest department of chemical philosophy, and expounds with commendable clearness the latest theories and hypotheses of chemists concerning the nature and relations of atoms and molecules, and gives a comprehensive *résumé* of the present state of what Dr. Meyer calls "chemical mechanics." Dr. Meyer tells us that, in arranging the subject-matter of his book, he has endeavoured to gratify the wishes of the representatives of the most varied natural sciences to obtain a nearer insight into modern chemical theories, and that he has also remembered "that such a review should not necessitate too much special study." There can be no doubt that the history of chemical theories during the "modern" period presents intense interest to students of the progress of scientific thinking. The modern period has two striking initial landmarks—the overthrow of the phlogistic theory, and the enunciation of the fundamental theory of John Dalton. Within this period the struggle between many opposing views, although "fought out within the chemical camp alone," has been severe and internecine, and the number and subtilty of the views themselves tend to prove that even within the laboratory the investigator is beset by the temptation to leave the safe ground of objective experience for perilous flights into subjective speculation. Dr. Meyer's work presupposes, in the reader of it, not only extended learning in the science of chemistry, but much information of what has been discovered and thought in the adjacent domain of physics. It is no sense a handbook for elementary classes, but advanced students will find it a valuable, richly furnished storehouse of fact and theory, which it will repay them to study, and, so far as may be, master. The history of "Modern Theories" is divided into three books or parts, of which the last was added in the fourth edition. In Part I. we find what is known of atoms. Here naturally the successive chapters are devoted to atomic weights and the nature of atoms, the treatment of their losses being fairly exhaustive. Here, as throughout the book, we observe the author's commendable practice of referring to the original works in which experimenters recorded their investigations, and the deductions from them; if bibliographic references are considered unnecessary, the investigators' names are given, so that further research on the reader's part is facilitated. Parts II. and III., devoted respectively to "Statics of Atoms" and "Dynamics of Atoms," are perhaps most replete with in-interesting matter. In statics we study the changes and progressive growth in views held by distinguished chemists of the "linking of atoms," and we see how these views have elucidated different questions in molecular combination and inter-action. The "Dynamics of Atoms" opens up and throws light upon the vast field of chemical change and its causes; and here we see how chemical change is effected and modified by mechanical disturbance, by heat and by light, or influenced by mass. In his conclusion the author gives a summary view of the present condition, and of the outlook of chemistry. In discussing the state of the theory of atomic linking, Dr. Meyer points out a possible danger, which, as already suggested, lurks in the path of the chemist. "It is the tendency . . . to treat chemistry as a deductive science." Should this tendency have unrestricted scope, its effect must be deadening; but perhaps the very best correction has been put into our hands by Dr. Meyer himself, in his impartial account of the rise and fall of rival hypotheses. The translators of the volume have achieved success in generally putting the author's work into clear, straightforward English, although there are, scattered through the volume, involved sentences, which, when straightened out, contain but a minimum kernel of definite meaning.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

April 18.—"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S. The Astronomer Royal, F.R.S., will preside.

April 25.—"The Physical Culture of Women." By Miss Chreiman.

May 2.—

May 9.—"Locks and Safes." By Samuel Chatwood.

May 16.—"Electric Lighting from Central Stations." By R. E. B. Crompton. The Attorney-General, M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings, at 8 o'clock:—

April 17.—"A Hundred Years' Progress in New South Wales." By W. F. Buchanan. B Francis Cobb, Treasurer of the Society, will preside.

May 15.—"Emigration." By James Rankin, M.P.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

April 24.—"Craftsman and Manufacturer." By Lewis Foreman Day. John Sparkes, Principal of the National Art Training School, will preside.

May 8.—"The Decorative use of Colour." By J. D. Crace. E. C. Robins, F.S.A., will preside.

May 29.—"Persian Textiles." By Cecil Smith.

Indian Section.

Friday evenings, at Eight o'clock:—

April 13.—"The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By W. R. Robertson, M.R.A.C., Principal, College of Agriculture, Madras. Sir James Caird, K.C.B., will preside.

May 4.—"The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab." By Surgeon-General H. W. Bellew, C.S.I.

The above dates are liable to alteration.

Cantor Lectures.

The Fifth Course is on "Milk Supply, and Butter and Cheese-making." By Richard Bannister. Three Lectures.

Lecture II.—April 16.—Our Butter Supply.—Changes, as shown by imports and exports.—Butter imported in fresh or salt condition, according to position of country of production.—Home producer at a disadvantage; why?—Co-operation necessary; its working.—Letting cows, creameries, lump butter, central factories.—Milk for butter making; its treatment.—Sour and sweet cream.—Setting milk in shallow and deep pans.—The Schwartz, Cooley, and other systems.—Cream separators, centrifugal machines, De Laval's separator.—Churning, how done.—Different ways of making up butter for market.—The Danish, Swedish, Dutch, and French methods. — Improvement in English methods. — Butter, its composition; its adulteration and methods of detection.—Butter substitutes.—Margarine (butterine), how made.—Legislation.

Lecture III.—April 23.—Our Cheese Supply. —Increased imports.—Best milk for cheesemaking. —Coagulation of milk, treatment of the curd, ripening.—Home-made cheese, Cheddar, Gloucester, Cheshire, Derbyshire, North Wilts, and Stilton.—Foreign-made cheese, American, Dutch.—Fancy cheese, Cream, Gruyere, Gorgonzola, Roquefort.

The Sixth Course will be on "Decoration." By G. Aitchison, A.R.A. Three Lectures. April 30; May 7, 14.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Richard Bannister, "Milk Supply, and Butter and Cheese-making." (Lecture II.)

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Sir Monier Monier Williams, "Mystical Buddhism in connection with the Yoga system of Philosophy."

Tuesday, April 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. W. F. Buchanan, "A Hundred Years' Progress in New South Wales."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Charles Waldstein, "John Ruskin." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Adjourned discussion on Mr. Arthur Ayres's paper, "Compressed Oil-gas and its Applications." 2. Mr. E. B. Ellington, "The Distribution of Hydraulic Power in London."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Herbert Druce, "Description of some New Species of Heterocera collected by Mr. C. M. Woodford in the Fiji Islands." 2. Mr. T. D. A. Cockerell, "Atavism." 3. Prof. G. B. Howes, "Notes on the Vocal Pouches of *Rhinoderma darwini*." 4. Mr. Oldfield Thomas, "A New Genus and Species of Rat from New Guinea."

Wednesday, April 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Howard Grubb, "Telescopes for Stellar Photography."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. James B. Jordan, "Jordan's New Pattern Photographic Sunshine Recorder." 2. Mr. William Doberck, "The Meteorology of South-Eastern China in 1886." 3. Prof. A. S. Herschel, "Lightning in Snowstorms." 4. Mr. Rupert T. Smith, "Insolation."

United Service Institute, Whitehall-yard, S.W., 3 p.m. Admiral Sir R. Spencer Robinson, "The Causes which have hindered the Development of the Army and Navy."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C. 7½ p.m. Discussion on Mr. A. M. Clark's paper, "The International Convention," and on Mr. Hardingham's paper, "Proposed Patent Law in Switzerland."

Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Spring Exhibition.

Thursday, April 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, 8 p.m. Messrs. G. W. A. Thurstone and J. T. Cundall, "The Influence of Temperature in the Composition and Solubility of Hydrated Calcium Sulphate and of Calcium Hydroxide."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Mr. Justice Cunningham, "The Public Health of India."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture II.)

Historical, 11, Chandos-street, W., 8½ p.m. Mr. G. Williamson, "The Historical Value of Traders' Tokens and the Minor Currency."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Friday, April 20...United Service Inst., Whitehall-yard, 3 p.m. Lieut. H. Chamberlain, "The Game of Naval Blockade."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir William R. Grove, "Antagonism."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. David S. Capper, "The Speed-Trials of the latest addition to *The Admiral* Class of British War Vessels."

Philological, University College, W.C., 8 p.m. Prof. Kuno Meyer, "Old Teutonic Syntax." (Part II.) "The Early Catechisms and Paternosters, &c., and the Eleventh Century Translations."

Saturday, April 21...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (With Illustrations.

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FRIDAY, APRIL 20, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. R. Bannister, F.C.S., F.I.C., delivered the second lecture of the fifth course of Cantor lectures on "Milk Supply and Butter and Cheesemaking," on Monday evening, 16th inst., the subject with which he dealt being the butter supply.

The lectures will be printed in the *Journal* during the autumn recess.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

Committee.—Sir Douglas Galton, K.C.B., F.R.S. (Chairman of the Council), Sir Frederick Bramwell, D.C.L., F.R.S., W. H. Barlow, F.R.S., E. C. Robins, F.S.A., Col. A. C. Hamilton, R.E.

A conference will be held on this subject, by the Society of Arts, on Thursday, Friday, and Saturday, May 10th, 11th, and 12th, 1888. The following, amongst others, are subjects on which suitable papers will be received:—

1. History of the rise and progress of canal and inland river navigation in Great Britain and Ireland.

2. Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c.

3. The canals of other countries.

4. Present condition of canal navigation in Great Britain and Ireland. Suggestions for its improvement.

5. Canals and railways—their mutual influence on each other.

6. Comparative cost of transport by railways and by canals. Tariffs.

7. The law of canals, and matters relating thereto.

Proceedings of the Society.

INDIAN SECTION.

Friday, April 13, 1888: Sir James Caird, K.C.B., F.R.S., in the chair.

The Chairman, in introducing Mr. Robertson, said that in consequence of the falling off of the imports of wheat from India, it became a matter of interest to everyone in this country to know whether that was likely to be permanent, and what was the cause of it, and as he had the honour of being acquainted with Lord Dufferin, he took the liberty of writing and asking whether he could offer an explanation. The fact was that in 1887-8 the importations of wheat from India fell to one-seventh of what they were in the previous two years. As many persons had a strong belief that India would probably be one of the largest sources of supply to this country, it seemed necessary and useful to make an inquiry of the highest authority upon the subject, and Lord Dufferin, with his usual kindness, had sent the following answer, which he received last Monday:—"I have deferred a reply to your inquiry as to the cause of the decline in the imports of Indian wheat to the United Kingdom until I could be provided with the most recent statistics available in the secretariat. I enclose the papers which have been furnished to me, and think you will agree that the inference to be drawn from them is that, whatever may have been the diminution of imports into Great Britain in 1886-7, the decline of exports from India did not really commence till 1887-8. In 1886-87 an increase in the exports to Italy made up for the decrease to the home country. The real check in exports did not take place until July, 1887, and has evidently been due to the short harvests of food grains in the preceding two years. The fluctuation in the stock of food grains in the country appears to have more influence than English quotations upon the price of wheat in India. Considerable apprehension was felt when in January last, the usual winter rains did not appear in Northern India. But, with their fall towards the end of the month, prices, which in some localities had approached a famine standard, began to fall, and there is now every prospect of a prosperous harvest." Along with this letter Lord Dufferin was kind enough to send the papers which he had obtained from the secretariat on the subject, and as there were

some points which were of general interest, he might be excused for shortly referring to them. It appeared that the exports from Calcutta in 1886-7 increased so largely as to more than compensate for the decrease of imports in that year, but the total export from all Indian ports in 1887-8 might be expected to fall below those of both preceding years. They certainly had fallen very considerably, and there was a material deficiency in the out-turn of food grains from Northern India, owing to the untoward character of the weather. In the Punjaub, the food grains in 1886-7 were deficient on account of want of rain and severe frost. In the North-West Provinces the spring crops were damaged by blight and frost. Whenever there was a material surplus of food grains in the country, the Indian export merchants could send wheat from India at a price which would enable them to compete with the lowest prices that ruled in India, but when the surplus was small they were unable to compete, even though they were supported by a rise in the markets in Europe. It was not the scarcity or abundance of wheat that ruled the price of food grains in India. When there was a great deficiency of other food grains which were consumed by the natives, the value of wheat rose in the same proportion as all other food grains, and in fact the very trade which had been opened up with this country and Europe generally for wheat had been the safety valve for the people of India for this reason, that when an unsuccessful season occurred in India for other food grains, the wheat which was grown for export could be turned for the purpose of feeding the people of India. As the price of food grain increased, the wheat rose in the same proportion, and consequently it would not pay merchants to export it. That was a natural safety valve by which the people of India were protected in time of famine. The acting secretary of the Agricultural Department of India had also sent an explanation, in which he mentioned that the rates of exchange and freight were lower than in 1886-7, but the trade had declined, owing to the supply not being abundant, when it paid merchants better to keep it at home. He (the Chairman) had never been very sanguine that Europe could safely depend on any great and continuous export from India, because of two things, first, there was an enormous population, rapidly increasing in numbers; and in the next place there was not, as there was in America, a great extent of good land which could be cultivated at a very little cost. The ordinary cultivation of the county was carried on by the people to the utmost extent to which it could be, and if it were wished to go further, large expenditure would have to be incurred, either in irrigating barren plains, or clearing jungles. Sir Edward Buck had stated that a very significant increase in wheat area had taken place in Behar, and that there was reasonable probability that, with a recurrence of good harvests, the surplus available for export would become gradually larger. England depended for two-thirds of its supply upon foreign countries, and in good years they might expect assistance from India, and upon large supplies from America. Ten years ago, when wheat was at 57s. a quarter, the cost of transport from the far west in America to the English markets was so great in comparison with what it was now, that there was as good a profit to the American farmer at 32s. a quarter now as there was at 52s. then. Though America was increasing in population, he was surprised to find that in the last seven years the increase would have taken 2,000,000 more acres to be sown to feed the people, but the acreage now was less than it was seven years ago. The result of the low price of wheat had been that rather more than one-third of the wheat acreage of these islands had disappeared, but it must not be forgotten that that which had gone out of cultivation was of the worse description. The two-thirds which was left was superior land, and he would strongly advise English farmers to continue growing wheat, believing that the production of wheat on good land would still be remunerative.

The paper read was—

AGRICULTURE AND ITS IMPROVEMENT IN SOUTHERN INDIA.

By W. R. Robertson.

I have already had the honour to submit two papers to this Society on agriculture in South India, and in venturing to invite your attention again tothe subject, I must explain that I have undertaken the duty in the hope that I shall be able to substantiate and emphasize the facts and conclusions I have already placed before you, rather than in the expectation that I shall be able to bring under your notice fresh facts and conclusions of importance. It is now nearly twenty years since I entered on the duties entrusted to me by the Government of Madras, connected with agricultural inquiry and agricultural education, a period, I think, sufficiently long to justify me in attempting to form definite conclusions on a few of the many important questions connected with the improvement of agriculture in South India.

It must be remembered that the Government in India hold a position in relation to the land quite different from that held by Government at home. Of course, in all civilised countries the protection and encouragement of agriculture are matters of national importance, but in no country is the prosperity of agriculture and the welfare of the people more intimately connected than in India, for the land contributes more than one-third of the whole revenue of the Empire, and supports, directly or indirectly, fully 75 per cent. of the

population. In Madras, the land revenue forms more than a half of the entire provincial income. Self-interest, therefore, if no other reason existed, should be a sufficiently powerful motive to induce the authorities in that province to institute measures for the benefit of its tenants, for they have to contend with difficulties of no ordinary character.

The State certainly has not full control over all the land within the province; about a third of the area is held under zemindari and similar tenures. But there remain fully 60,000,000 acres, of which the cultivated area is nearly 25,000,000, an area larger than the cultivated area in the United Kingdom, over the farming of which the State may exercise a very direct influence. There is much misapprehension as to the exact terms of the ryotwari tenure under which chiefly this land is held. I have not time now to discuss this matter, but as it has a considerable bearing on some of the questions I intend bringing under your notice, I have compiled from the recently published "Manual of Administration in the Madras Presidency," a memorandum on the ryotwari tenure, which will be found at the end of this paper. It will be seen from this memorandum, that there is nothing to prevent State interference in the farming of this land, while there are very strong reasons why such interference should be judiciously exercised.

The State rent being calculated on the produce of the land, the revenue therefrom will necessarily be greater or smaller as the land is well managed or negligently treated. Vast sums are annually lost to the State from the necessity of granting remissions of rent for failure of crops, and for short crops due to unfavourable seasons or other causes. The last "Moral and Material Progress Report of India" shows that in 1884-85, the latest year for which figures are available, the remissions of rent in Madras amounted to £487,842; and the "Manual of Administration," before referred to, gives the loss of land revenue during the two years ending 1878, the famine period, as upwards of £2,000,000; though, during these years, the State expended upwards of £7,000,000, chiefly in the support of the people dependent on the land.

I am not prepared to assert that if the land was farmed as it should be there would never be a famine, and never any occasion to grant remissions of rent, but I have no hesitation in saying that if the standard of farming was raised in Madras to anything like that of this country—and we must all acknowledge the many imperfections of our farming—famines would be less frequent, and never so severe as that witnessed in Madras in 1876-78, while there would be less necessity for making annually large remissions of rent.

It must be admitted, I think, that if it is the duty of the State to undertake the new responsibility of protecting the people against famine, the State has the right to expect that the people engaged in husbandry shall make the best use of their opportunities, and thus aid in giving effect to the new policy, or in reducing the necessity for its extensive operation. I might also invite attention to the fact that the enormous outlay of State funds on railways, canals, irrigation works, &c., will never be likely to bring in a fair return unless agriculture is prosperous and progressive.

In later years, the Governments of all the provinces of India have, at one time or other, evinced anxiety, in different degrees, regarding the husbandry of the people ruled by them; and have attempted in different ways to give effect to measures they considered calculated to lessen or remove the grounds for these anxieties. In Madras, under the influence of the then Governor, the late Sir William Denison, who took a deep interest in agricultural improvement, the direction this took was, the establishment, in 1866, at the Presidency town of a committee of influential military and civil officers, amongst whom were Major-General Michael, C.S.I., who has done so much for the sister subject, Indian forestry; Major-General Shaw-Stewart, Mr. Justice Brandt, the late Mr. J. Hunter-Blair, the late Sir William Robinson, and others, to whom was entrusted the general direction of certain agricultural inquiries to be instituted, and the control of the necessary funds allotted by Government.

The committee began by clearly recognising that there must always be a considerable difference in the agricultural practice of India and Europe, though Eastern and Western agriculture are necessarily based on the same great principles; that, while the agriculture of India is antiquated and stationary, that of Europe is modern and progressive; that, while in India the educated and wealthier classes take no interest whatever in agriculture, in Europe agriculture has the sympathy and aid of these classes.

A tract of land of about 300 acres was

transferred to the charge of the committee. Much of the land consisted of barren sand, but a little better than that of the seashore, and the whole of the estate needed a large expenditure. But, the property had an important advantage in its position and accessibility, while for the special objects of the committee — agricultural inquiry — the adverse agricultural conditions were not, on the whole, disadvantages.

Convinced that it was in countries circumstanced somewhat similar to South India, rather than in European countries, that helps and aids for the improvement of Indian farming would be found, the committee entered into correspondence with persons living in Egypt, Northern Queensland, the hotter parts of China, the Southern States of America, and elsewhere, through the agency of whom they obtained agricultural seeds, implements, machines, and live stock likely to do well in the climate of South India, and suited to the circumstances of the native farmer. But the help that could be afforded in this country was also taken advantage of, and small ploughs and other tillage instruments were obtained from Messrs. Howard & Co., Messrs. Ransome & Sims, and others.

Up to 1871, when the committee was dissolved, and the charge of the work was entrusted to me, the Madras Government had not prescribed any definite line of inquiry, but in that year they formulated their views as to the general direction the inquiries should take, under my charge, as follows :—

1. To ascertain by experiment the proper use of rotation of crops.

2. To introduce a system of root or green crops in lieu of fallow, without artificial irrigation.

3. To introduce new crops.

4. To provide new kinds of seed, and fresh seed for the crops now cultivated.

5. To make experiments in the use of water for the cultivation of crops now termed "dry" crops, and for raising grasses and other crops to be used as fodder.

6. To make experiments in the use of lime and other manures—mineral, animal, and vegetable.

7. To introduce new and improved implements and machines of rural labour.

8. To improve the working cattle, sheep, horses, and other varieties of live stock.

These objects have been steadily kept in view, as far as the means and opportunities at my disposal allowed. The chief work has always been carried on at Saidapet, for we had no other experimental station, and until recently no co-workers in the whole province in this field of agricultural inquiry and work. But much was done to excite amongst native farmers an interest in these objects by means of agricultural shows, ploughing matches, demonstrations made in different parts of the country in working improved ploughs, machines, &c., and, by the publication of papers in the different native languages of the province, giving the results of numerous experiments conducted at Saidapet, in tillage, manuring, cropping, stock breeding and feeding; and in introducing and adapting to the circumstances of South Indian farming, improved implements for tillage, machines for seed sowing, raising water, cleaning grain, cleaning cotton, shelling maize, crushing sugar cane, &c. While direct aid was afforded native farmers by the free distribution of superior seed and plants, by lending them ploughs of improved patterns, and training their labourers to use these ploughs, and keep them in repair; by stationing bulls and rams of good breeds where their services could be utilised; while any advice or aid that an agricultural officer of Government could afford was always freely at the disposal of anyone engaged in agricultural pursuits. To such an extent was this last privilege availed of, that my office correspondence, chiefly with native landholders, at one time exceeded 2,000 letters annually.

Side by side with this work of inquiry, demonstration, and record, a system of agricultural education was gradually springing up and developing. At first, it consisted merely in giving a few youths—engaged as farm apprentices—opportunities at Saidapet of making themselves acquainted with the use of improved implements and machines, of gaining a knowledge of the use of manures not employed in native agriculture, and generally of becoming acquainted with the application of correct principles in the treatment of crops and live stock. Some of these men were much better educated and probably possessed as much farm knowledge as the average native farmer, but it was soon found that, however well they might learn to copy what they saw done at the farm, they would never be of any use in helping to reform the agriculture of their country.

It should always be remembered, in connection with agricultural education in India, that amongst the agricultural population, probably not 50 in 1,000 are able to read and

write even in their own language; that nearly 90 per cent. live and die in the village where they were born, and that the cultivation of some crops is so local, that a practical native farmer may never even have seen the chief crops of his province. It may seem in this country almost incredible that a so-called practical India farmer may know no more about the culture and treatment of cotton, indigo, rice, sugar cane, tobacco, and some other tropical crops than an English farmer, and yet such is the fact, even though hundreds of thousands of acres in South India are annually under these crops.

The necessity of obtaining better educated men, to be specially trained for employment under the State, in duties connected with the improvement of native husbandry, was early recognised. But, unfortunately, though very favourable terms were offered to induce such men to offer themselves, the feeling at that time amongst the native educated classes was so strong and general that agriculture was far too mean a pursuit for educated men to engage in, no man possessing the needful qualifications offered himself.

It being generally acknowledged that the greatly-to-be-desired reforms in native husbandry could be effected only through the agency of natives themselves, the necessity of instituting a system of agricultural instruction gradually forced itself into notice, and the result was the establishment of a school of agriculture at Saidapet. This institution was begun as an experiment, and was intended chiefly for training men for State employment in duties connected with agriculture; but other educated youths belonging to the landed classes were also to be admitted to the benefits of the institution. It soon became necessary to establish the institution on a permanent footing, as when its objects became fully understood, and its methods of work known, students came to it from all parts of the Empire, more especially from the native States. The following native States sent students, and in most cases paid all their expenses: — Mysore, Travancore, Indore, Patiala, Berar, Kattywar, Dewas, Gondal, Wadwhan, Ullwar, Kolhapur, Vizianagram, Karvetnagar, Kalahastri, and others. The institution has grown gradually, and has steadily developed into a college, and is now known as the Madras College of Agriculture. Until recently it was the only agricultural college in the vast agricultural empire of India.

I have not time now to relate further the history of this institution, but hope some day I may be allowed to do so before this Society, as there is much of interest in the experiences connected with its establishment and gradual development. I must content myself now by saying that the college has fully realised the expectations under which it was founded, and is, I believe, doing good and useful work. It is proving especially beneficial in bringing back to agriculture the more intelligent and enterprising of her sons, who, under the influences of a purely literary education, were gradually abandoning the pursuits of their forefathers for a career which, even to the successful, held out nothing better than a poor clerkship under Government. Upwards of 150 students have gone through the college course. Nearly the whole of them are now usefully employed, chiefly in connection with agriculture, in widely scattered places all over the Empire.

The agricultural college has stimulated and aided agricultural instruction all over the province, and in the other provinces of India, and much useful work is now being done; and in future this will be on a far larger scale than has hitherto been possible; for in Madras all men intending to become school teachers will, under arrangements recently made, now go through a course of agricultural instruction in the College of Agriculture.

The subjects I have yet to bring under your notice are so numerous, that it will, I think be the most convenient course to follow, to take them up in sections, and probably the simplest method of proceeding will be to make these agree in matter and arrangement with the sections of the programme of objects, to which I have already directed attention. Following this course, the subject that comes first under notice is

Rotations in Crops.

Remembering that the agricultural people of South India are almost entirely uneducated, possess no agricultural literature worthy of the name, and have hitherto had little or no intercourse with the people of other countries (where a progressive agriculture is found), it is not surprising that they possess no knowledge of the principles of crop rotations. The people are aware that it is unwise to grow sugar-cane, for instance, for a succession of years on the same land, for this crop is such an exhausting one, the ill effects of its frequen

repetition on the same soil is too obvious to be overlooked.

The great discoveries of modern science in connection with the chemistry of the soil, the feeding of plants, &c., are, of course, still unknown to Indian farmers; and they are equally ignorant regarding the more obvious facts of natural history, on the proper recognition and appreciation of which so much depends in prescribing a suitable succession of crops. I do not forget that in this country rotations of crops were adopted before the principles on which they were based were understood, but their general adoption occurred in a stage of agricultural progress, very far in advance of that yet reached in South India.

Mixed cropping is practised in many parts of the province, that is, two or more crops are either sown together at one time in one operation, or the sowings are made at short intervals of time, either broadcast or in lines. But the object with which this is done, has nothing to do with the principles on which crop rotations are based. In many parts of South India, the cropping of the "dry" land, as generally managed, is attended with great uncertainty; and it is to meet this difficulty that mixed cropping is practised; for, when two or three different crops are sown together on the same land, there is always a prospect of at least one of the crops giving some produce. Of course, when this mixture consists of crops widely differing in their character, and in their demands on the soil, frequent repetition of the mixed crop on the same soil, is less objectionable than would be the frequent repetition of a single crop.

In an average year the cropping of the Madras Presidency is :—

	Per cent.
Grain crops	75
Pulse crops	10
Cotton, tobacco, sugar, &c.	7
Oil seeds	5
Plantations, orchards, &c.	3
	100

It must be obvious to anyone who understands anything whatever about the principles of crop rotations, that no proper rotations can be generally practised when one kind of crop constitutes 75 per cent. of the whole crop raised.

In Madras, 85 per cent. of the cropped area is producing corn crops. In this country only about 30 per cent. of the cropped area is under corn crops. It will be seen how much more severe is the cropping in Madras, and therefore how much greater is the necessity in that province for crop rotations being generally adopted. The circumstances of the province differ so widely, no set rotation of crops could be generally followed. Several different rotations, suited to the various circumstances of the country and people, have been suggested. Not only can much be done by adopting suitable rotations to conserve the fertility and condition of the soil, but many crops that, under present management, are very exhausting, may become under proper treatment really restorative in character. I come now to—

Root Crops, and Green Crops, in lieu of bare fallow.

In Madras, upwards of 5,000,000 acres of cultivable land—nearly a quarter of the whole area—are usually under what is termed "bare fallow." But this term is incorrectly applied, for the land is simply abandoned for a shorter or longer period, and becomes overgrown by weeds and wild shrubs.

I need not remind you that in Europe a "bare fallow" is usually thoroughly tilled. Thorough tillage hastens and intensifies the restorative influences at work in a soil undergoing fallowing. My experience in India shows that this tillage should be done expeditiously, and should not be prolonged over too long a time, and that the soil should be covered as soon as possible by some green crop, or the intense heat of the sun will cause a loss of organic matter—a very serious loss indeed in a soil under a tropical climate. Investigations at Saidapet have shown that a large per-centage of nitrogen accumulates during the hot season in the soil, and that the early light rains bring a much larger quantity of nitric acid than do the rains in this country. This nitrogen, being taken up by the roots of the green crop, is retained in a form in which it is safe against the washing-out influences of the heavy monsoon rains.

Of course, the wild, jungly vegetation, that covers the so-called fallow land, will to some extent act in the same way as a fallow crop, in conserving the nitrogen of the soil, but this can be the case only to a limited extent. Probably the rigid revenue regulations constitute the chief reason why the fallow land receives no tillage, for if a plough is put into the land the rent must be paid, otherwise the land is exempt from the payment of rent. Native farmers have, however, no great inducement

to make the best use of their land. The system under which they may relinquish all, or any part of their land they have exhausted, and take up fresh land in its place, is, I think, most objectionable. The area relinquished annually in this way is, in Madras, nearly a million acres.

My experience is that a green crop might be grown on nearly the whole of the land now bare fallowed. We have no root crops in Madras, such as turnips or mangolds, and the climate generally is too hot for these crops, but there are many indigenous cereal and leguminous crops that may be grown easily in almost all parts of the province without the aid of irrigation, that yield excellent fodder. Amongst these are, *Sorghum vulgare*, *Panicum spicatum*, *Panicum miliaceum*, *Panicum miliare*, *Panicum italicum*, *Dolichos uniflorus*. Some of these will, under ordinary cultivation, in the space of from 75 to 85 days, yield from 10,000 to 15,000 pounds of excellent fodder per acre, and all the cereals will give two or more cuttings, if sown at the right time of year, and cut in the right stage of growth. I would like to say more on this important subject, but I must pass on.

Introduction of New Crops, and of better Seed of Crops already grown.

About 20 years ago, on the suggestion of Dr. Forbes Watson, F.R.S., attempts were made to introduce Carolina rice into South India. Dr. Forbes Watson pointed out the fact that Carolina rice in the European markets usually sold for a price nearly twice as great as ordinary Madras rice. Through his agency a quantity of Carolina rice seed was obtained direct from the United States and forwarded to Madras. The average temperature of the rice districts of Madras in the cropping season does not differ greatly from that of the rice region in South Carolina, at the time of year when the rice is cultivated.

The seed was widely distributed in all the rice-growing districts of the province, and it was sown ordinarily under the same conditions as the common rice. The cultivation was left entirely in the hands of the people willing to undertake the experiments, though papers containing suggestions for their guidance were printed in the vernacular and distributed with the seed. In a number of widely scattered places the new crop grew well, and yielded in some instances heavier crops than the common rice grown under similar conditions. But a wide experience showed that the seed belonged to a stage in agricultural progress that had not yet been reached in South India. The general results showed clearly that the slovenly treatment to which the common rice is generally exposed, is much more pernicious in its effects in the case of Carolina rice. Crops of the common rice grew and gave fair results under conditions that proved disastrous in the case of the higher rice.

The Carolina rice plant was found to have long roots that feed deep down in the soil, while the roots of the common rice spread over the soil, and form into a net-work over the liquid mud on which the crop grows. Ordinarily, in Madras, the soil for rice is shallow tilled, and is worked, while under water, into a puddle. Under this treatment the under soil becomes sour and unfitted for healthy root growth. A soil in this state would be utterly unsuited for the growth of a crop of Carolina rice, and yet a fair crop of the common surface feeding rice might be produced on it.

Further supplies of seed were obtained, and the experiments were repeated, but the general results were all similar. When the soil was deep and healthy, with fair under drainage, and the irrigation water was used with care and judgment, good crops were produced; under the opposite conditions the crop generally failed.

It is doubtful, however, whether if the cultivation was better, and the crop generally succeeded, the rice produced from the Carolina seed in Madras, would sell for a much higher price than that for which ordinary Madras rice sells, unless the method of husking and preparing the rice for market was raised to the American standard. I sent a small consignment of Madras grown Carolina rice, prepared in the ordinary native method, to this country to test this question, and the price realised, though higher than that of any Madras rice sold at the time, was considerably below that at which American Carolina rice was then selling.

It being generally believed in the United States that Carolina rice was introduced from Madagascar, I obtained from that island a number of samples of the varieties of rice generally cultivated; and amongst these was pleased to find one variety, known as Rajafatsky, that resembled somewhat Carolina rice, a resemblance I found much closer when I saw the crops of the two kinds of rice growing. If this is not the variety of rice from which the Carolina originated, it is, nevertheless, a variety well worthy of attention in South

India, it possesses so many of the good points of the Carolina, while it has been grown under the same rude agriculture as prevails in South India. One of the chief points of importance, common to both the Carolina and Madagascar rice plants, is that they are much less aquatic in their habits than the ordinary rice, and consequently may be grown with an expenditure of much less irrigation water.

I may mention that amongst the samples of rice received from Madagascar there were some not unlike some kinds of Madras rice. May it, therefore, not be possible that Madagascar obtained the rice plant from India, and that the so-called Carolina rice may be descended from Indian rice, its excellencies being due to good cultivation in a virgin soil, under a favourable climate.

Maize was another cereal that engaged our attention at about the time we were introducing Carolina rice. Maize is almost unknown as a field crop in South India. A few different varieties were obtained from the Southern States of America, Egypt, Queensland, the Cape, and elsewhere. The best results were obtained in growing the Queensland seed; it appeared to need no acclimatisation. Heavy yields of grain and straw were obtained from sowings of this seed. The straw proved to be especially rich in saccharine juices. I had some experiments made in extracting this juice, and in making jaggery (crude sugar) from it; following in this the usual native process. The results showed that from 100 pounds of fresh straw three pounds of jaggery could be made. This jaggery, on analysis, was found to contain 34·99 per cent. of crystallisable, and 11·46 per cent. of non-crystallisable, sugar. This maize was produced on a soil containing nearly 90 per cent. of sand; on a good soil the yield of saccharine juices in the straw would of course be much greater. The refuse straw, after being crushed in squeezing out the juice, formed excellent cattle food. The maize crop may thus yield grain for the food of man and stock, a crude sugar, and straw.

Very good results were obtained in growing maize in alternate lines with cotton. It was found that the shelter the maize plants afforded the young cotton plants was very beneficial; while as the maize was removed before the cotton needed the whole of the land, the cotton crop suffered in no way. Ordinarily cotton occupies the land in Madras about nine or ten months, and maize about three months. Both crops being sown at one time, the maize crop was usually harvested when the cotton plants were just beginning to throw out their side branches, and needed the extra space. This combination of crops removes one objection usually made to cotton culture in South India, where food for man and beast is so much needed, that cotton culture provides no food for man, and but little food for stock.

Unfortunately, maize has made but little progress as a field crop, owing chiefly to the inferior character of the cultivation generally adopted. A short time ago I saw a lot of cobs that had been received from one of the districts in which the crop had been persistently cultivated, and none of these weighed more than one-seventh of the weight of the average cob produced by the first sowings of the imported seed.

The sugar sorghums received a great amount of attention. *Sorghum vulgare* is extensively grown in South India. The area annually under this crop is over 3½ million acres. The black seeded, yellow seeded, red seeded, and white seeded varieties are all grown. All give fair yields of grain and of straw; but the straw generally contains no saccharine juices worth extracting. As far as has yet been ascertained, there are no sugar sorghums indigenous to South India. It was therefore considered desirable to introduce some. Seed was obtained from China, from Queensland, from the Cape, and from the Southern States of America. The varieties introduced were the *saccharatum* and the *Kaffrarium*. Both grew well in all parts of the province, and the straw proved to be rich in saccharine juices. An average sample of the juice of the *saccharatum* was found to contain 10·59 per cent. of crystallisable, and 1·79 per cent. of non-crystallisable, sugar. Ordinary sugar-cane, I may remind you, contains about 15 per cent. of crystallisable sugar, and about half as much of the non-crystallisable.

Comparing ordinary sugar-cane with sugar sorghum, the former needs a rich deep soil, necessitates a large expenditure in preparing the land and providing the cane sets, &c., demands regular irrigation during its entire growth, and occupies the land over twelve months. The sugar sorghum will yield fair crops on very ordinary soils, the seed is cheap, and the land needs no expensive preparation, irrigation is unnecessary in ordinary seasons, and the crop never occupies the land longer than from three to four months; while, unlike the sugar cane, the sorghum will yield grain, a crude sugar, and a feeding straw.

The sugar of the juice of the ordinary

S. saccharatum (the Chinese sugar-cane), always crystallised with difficulty, but that of the juice of a variety known as the early amber, and that of the juice of the *S. Kaffrarium*, usually crystallised freely, though as far as our experiments went, in neither case was this so readily or perfectly as in the case of the sugar of the juice of the ordinary sugar-cane. However, as far as regards the manufacture of jaggery, as large an out-turn was obtained from sorghum juice as from sugar-cane juice.

All the ordinary cereals of South India received more or less attention, but I have not now time to refer to other cereals. I may just mention that nearly all these cereals yield small seeds with a considerable per-centage of husk, and usually contain but a small per-centage of albuminous matter. The pulses are better, as a rule, but the area of land occupied by the pulses is small. This is much to be regretted, both on agricultural and physiological grounds, for cereals occupy far too much of the cultivated land, and pulse is so specially needful in the diet of a non-flesh-eating people.

In many respects the soils and the climate of the province are suited for cotton culture; indeed, there are vast areas of black soil, specially fitted for the crop. But, while the average yield of cotton in Madras is only 70 pounds per acre, the average yield in the cotton States of America is over 300 pounds per acre, while American cotton usually sells here for from 25 to 50 per cent. more money than Indian cotton.

The desirability of improving the quality and the yield per acre of the cotton crop has long been recognised; and efforts have been made to introduce better varieties of the plant, and improve the system of its cultivation. Much attention was given to this matter more than forty years ago, under the direction of an eminent botanist, Dr. Wight, but unfortunately he failed to recognise how intimately the question of cotton improvement is connected with that of agricultural improvement, and, instead of endeavouring to improve the system of agriculture, confined his efforts to cotton culture.

At Saidapet attention has been given to the introduction and distribution of good seed of the New Orleans, Yca Valley, Egyptian, and one or two other well-known varieties of cotton. New Orleans has been particularly successful, and by carefully selecting the seed for several years, the proportion of lint to seed has been greatly increased. The New Orleans has proved a heavy cropper, and a hardy plant. The Yca Valley, a Peruvian variety, obtained through the agency of Mr. Clements Markham, C.B., was found to grow and thrive, under good cultivation, near the coast. A sample of this lint was valued in Liverpool at a higher price than any other kind of cotton on sale at the time, from either India, or Egypt, and as high as the best sample of American cotton. The plant is, unfortunately, very liable to the attacks of the grub of a coleopterous insect. The Egyptian cotton grows well in Madras, and the same may be said regarding the Hinginghaut, and one or two other kinds, introduced from Bombay.

Tobacco is another crop to which much attention has been given; it is grown in all parts of the province, but only in small plots. The total area of land usually cropped with it is only about 80,000 acres, in a cultivated area of over 22,000,000 acres. The plant grows well in most parts of the province, and fair crops are raised, but generally the leaf is inferior, from its poverty in mineral constituents; and the curing to which it is subjected is always unsatisfactory. The tobacco is almost unsaleable in this country, though the cheroots made at Trichinopoly meet with a certain amount of appreciation.

At my suggestion samples of tobacco from all the chief tobacco-growing districts were chemically examined. More than 50 samples were analysed. The investigation was confined to a determination of the per-centages of nicotine and ash, and the per-centage of carbonate of potash in the ash, in the dry manufactured leaf. The results of these investigations were valuable and suggestive. Nicotine varied from $1\frac{1}{2}$ to 7 per cent.; the average was about 3 per cent. The per-centage of nicotine determines what is usually called strength in tobacco; when there is over 4 per cent. the tobacco is a strongly intoxicating one. Havana tobacco contains usually about 2 per cent. The per-centage of ash averaged about 20; in a few cases it was over 25, but there were others in which it was under 15. The greatest variations were in the per-centages of carbonate of potash in the ash. In 39 of the 50 analyses made, the per centage of carbonate of potash was under 7, the majority being under 5; in some instances it was as low as 0·78. One sample, grown on the Neilgherry hills, contained nearly 30 per cent. of carbonate of potash in the ash, and five samples, grown in other thinly populated

parts of the province, contained from 10 to 17 per cent. The potash in a tobacco influences greatly its burning, the larger the per-centage the better it burns and the whiter is the ash. Samples of tobacco produced in the United States contain frequently as much as 35 per cent. of carbonate of potash in the ash. The low per-centage of carbonate of potash generally found in the ashes of the tobacco of the older cultivated districts of Madras is a sure indication of the poverty of the soils in potash, a mineral food, it must be remembered, of the greatest value for nearly all kinds of cultivated plants.

The close connection between the per-centage of carbonate of potash in the soil, and in the ash of the tobacco grown on it, was shown in a remarkable manner in some tobacco experiments conducted at the Saidapet farm, the soil of which, in 1868, contained but a trace of this mineral. In 1871, the tobacco produced gave an ash containing on the average only 0·6 per cent. of carbonate of potash; in 1879, after seven more years of improved cultivation, 9 samples of tobacco, produced in the same year, were analysed. Of these, the ash of 4 samples was found to contain nearly 5 per cent. of carbonate of potash, and the ash of all the remainder contained each more than 3 per cent. In other words, the percentage of carbonate of potash was fully 12 times greater.

Tobacco seed of good varieties was obtained from the United States and other countries, and distributed to cultivators, along with suggestions for the more careful selection of soils and treatment of the crop. Special attention was devoted to the curing of the tobacco; the native system being a highly unsatisfactory one, chiefly in the excessive fermentation to which the leaf is exposed.

While efforts were made to introduce seed from other countries, suited to the wants of the province, the fact was not overlooked that in some parts of the country superior varieties of indigenous crops are grown, the seed of which might with advantage be introduced into the more backward or less favourably situated tracts of country. Attention was directed to this by means of agricultural shows, and in other ways. There is nothing, I think, which more convincingly shows the apathy and want of enterprise amongst the agricultural population of South India than the fact that the people, over large tracts of country, will persist in sowing year after year seed of inferior varieties of farm crops, when frequently seed of better varieties can be got within a distance of 20 or 30 miles, at an additional expense of only the carriage of the seed. It must, however, be remembered that the native cultivator has to depend chiefly on his own resources in getting fresh seed, as there are no field seedsmen in India as there are in Europe.

I come now to my next section—

The Irrigation of so-called "dry" Crops, and the Cultivation of Grasses, and other Fodder Crops.

Upwards of 80 per cent. of the crop of the province depends on a very uncertain rainfall. It will readily be understood how crops suffer in some seasons when, for months together, no rain falls, and the land is exposed to the full heat of the sun in a cloudless sky, the out-of-door temperature at the time during the day varying between 120 and 135 degrees. At such times, the ability of the farmer to give his crop even a single watering is a great advantage, one such watering frequently saving a crop. Experiments at Saidapet and elsewhere have shown that a supply of irrigation water, even so small a quantity as the equivalent of one inch of rainfall, possesses not unfrequently a money value considerably exceeding the annual rent of the land irrigated by the water.

When it is remembered that in producing a crop of rice the cultivator ordinarily uses a quantity of water of a depth of from 9 to 12 feet over the whole area cropped, the desirability of reducing the area growing rice, and increasing the irrigable area cropped with the so-called "dry" crops, becomes obvious.

Experiments on the sandy soils at Saidapet have shown that, even in the driest season, crops of maize can be produced, by the use of a quantity of water not more than two feet in depth over the land cropped, that will yield a larger quantity of food for man and beast than is usually obtained by the expenditure of five times the quantity of water in growing rice; and very similar results have been obtained in growing, under occasional irrigation, the ordinary food cereals of the country.

During the famine period of 1876-78, when thousands of people were dying from starvation, and millions were suffering the pangs of hunger, there were many localities in which there was enough water available to suffice, if used judiciously on a properly prepared soil, to bring to maturity crops of ragi and other so-called "dry" cereals. But the water was unused, and the land allowed to remain bare,

because the water was insufficient for the ordinary requirements of a crop of rice, which crop only the people cared to grow on the land. It is true that the physical state of much of the irrigable land is so bad, from the "swamping" and "puddling" the soil has undergone, that the land is fitted only for semi-aquatic plants; but there are vast areas of irrigable land, either terraced or resting on a porous subsoil, that no ill-treatment of the kind can injure permanently.

The value of occasional irrigation for cotton, indigo, and other crops not usually irrigated, has also been clearly demonstrated. But, in raising fodder crops, the advantages of being able to irrigate the land occasionally during a drought, are especially great, for at such times the indigenous grasses wither up, there is no grazing, and great numbers of farm stock die from starvation.

There is on the plains in South India no grass land worthy the name. Grass seeds are never sown by native cultivators, and therefore no land is ever specially laid down to grass. The so-called grass-land is generally cultivated land that has been temporarily abandoned, which has become covered more or less with scanty tussocks of coarse, usually reed-like grasses, mixed with, if the soil is good, creeping grasses, of which one, at least, the *Cynadon dactylon*, is a useful grass, capable of bearing a long drought, and which, under cultivation and regular irrigation, is a heavy producer. It is this grass, with its long rhizomes, that constitutes the fodder of horses over India generally. Investigations yet made have failed to discover any really good indigenous grass in South India, suited for use in the way rye grass is used in this country. English grasses have been introduced, both direct from this country, and from the hotter parts of Australia where they had been partially acclimatised. Usually they grew well enough on the hills, and on the higher tracts of country where the climate was not so hot; but, on the plains, they failed altogether in the hot season.

Guinea grass (*Panicum jumentarium*) has become thoroughly acclimatised. When first introduced into Madras, and for some time after, it was regularly irrigated, and at that time its habit was such that it would not live unless regularly irrigated. This unfortunately greatly restricted the cultivation of the crop, but by steady perseverance we have changed the habit of the plant altogether, and I have had crops that for four or five years grew well and depended entirely on the rainfall. The change was produced by gradually lessening the quantity of irrigation water used, and by gradually increasing the intervals between each irrigation. In this way the character and habits of the roots have undergone great change; the plant no longer feeds near the surface, but sends its roots deep down into the subsoil. The result of this is that guinea grass may now be, and is, cultivated as a crop in rotation, and occupies the place that rye grass does in rotations in this country. The grass is a most valuable one, and is suited for use either in the green or dry state. It is eaten greedily by all kinds of stock; experiments have shown that either as a feeding or milk-producing grass it has no equal in South India. In very dry weather its blades wither, but fresh ones rapidly appear after rain. It bears regular cutting. Under irrigation it gives very heavy crops.

The next section of my subject is—

Lime and Other Manures.

Lime is not employed as a manure in South India; the ordinary cultivator has no idea whatever that lime could be so used. Owing to the costliness of fuel, the price of lime—sometimes as much as 30s. per ton—prohibits its use in the lavish way it is applied to the soil in this country. On the black soils, and on thousands of acres of other land, the application of lime would effect much good. But, on the whole, the non-use of lime is not altogether a cause of regret, and will not be so, as long as the present system of agriculture prevails. At its present price, however, the people cannot afford to make much use of lime; but if the expectations are realised of getting cheap coal, we may have soon a great reduction in the price of lime. The soils of South India are formed generally out of gneiss and similar rocks, in which lime is nearly entirely absent. Were bones used as manure, lime could be supplied in this way, but they are not used by the native cultivator. There are probably not 100 acres in the 22 million acres annually cropped, that have ever been manured with lime or bones Yet bones are exported from Madras to Ceylon and other places, and large quantities are used by the tea and coffee planters on the hills.

The low per-centage of phosphoric acid in Indian grain, shows the necessity for the use of bones as manure. I am strongly inclined to think that the inferiority of South Indian farm stock is to a great extent due to the

poverty of their food in bone-producing matters. My own experience is, that imported stock do not rapidly degenerate, as is the general experience, when fed on food containing a sufficiency of phosphate of lime. This, of course, has a very important bearing on the horse-breeding question.

We are frequently told that the Indian cultivator uses all the manure he can get. I have no hesitation in stating, of three-fourths of the land cropped, that none ever get what would be considered in this country half a manuring, whilst the greater portion does not get a particle of manure. Caste and other reasons prevent the use of night-soil, though, as will readily be understood, this manure is available in considerable quantity; and wood being extensively used for fuel, wood ashes for mixing with night-soil can always be readily obtained.

Saltpetre is manufactured in many places in the province, and the crude salt can generally be purchased at a moderate price. It has proved specially valuable as a top-dressing in experiments that I have conducted. Saltpetre is not used in native agriculture.

Farm manure is not prepared in the way it is in this country. The stock are seldom bedded, and usually stand on the bare ground; the result is, the manure collected consists only of the solid excrement, the more valuable urine evaporates or sinks into the ground, or, perhaps, flows into the village tank. But cattle manure, poor as it is—the animals being generally half-starved for long periods in the year—is frequently wasted by being thrown into a heap, out of doors, where it stands exposed to the rain and the hot sun until wanted. Owing to the scarcity of wood, and its high cost in many places, the people are compelled to use the solid excrement of their cattle as fuel, and in this way the supplies of manure are still further lessened. Even the ashes of cattle dung, which might be of great use, seldom go back to the soil, except after they have lost all their soluble and more valuable salts from exposure to rain. I have found the loose-box system of housing cattle well suited to the conditions of South India, while the manure collected is very superior.

Oil seeds being so largely grown, it might be supposed that there would be an abundant supply of manural oil-cake in the country; and in some places it is abundant, more especially the castor variety. However, a large proportion of the oil seeds grown are not crushed in India, but are exported. And even where manural oil-cake is abundant and cheap, it is but little used by native farmers, though the European planters on the hills use large quantities. I must pass on to the next section—

New and Improved Implements and Machines.

The latest agricultural statistics of Madras show that there are about 2¼ millions of ploughs in use in the province. These implements are almost exactly the same as the plough shown on the Egyptian stone tablets in the British Museum, and probably differ in no important respect from the plough used in all countries at one period, for they are but little removed from the "bent bough with the hardened point," which was probably the first aid employed in tilling the soil.

Native ploughs differ but little in general construction, though they vary greatly in size and in weight. I have seen specimens that weighed much heavier, and were of much greater draught, than any plough except a steam one used in this country; but these large implements are but little used, and are met with only in the black-soil districts. Such ploughs are generally drawn by eight or ten pairs of cattle. The ordinary native plough is small, and of light weight; on the average it does not weigh more than 30 to 40 pounds.

The smallness of the holdings of South India is, by some people, considered a difficulty in the way of the introduction of improved implements and machines, but there are in Madras more holdings over 20 acres in extent than there are in Ireland, which gives employment to all kinds of improved implements and machines. The inferiority of the plough cattle generally used is a more serious difficulty, but this may be met in the way the difficulty in drawing the heavy native plough is overcome, that is, by making use of two or more pairs of cattle. Over a very large area of South India an average sized plough bullock is not more than 250 pounds in weight, that is about the weight of a Cotswold ram.

The low price of agricultural labour, 2 to 3 annas a day, does to some extent lessen the necessity for employing labour-saving implements and machines. But labour cannot generally, in India, be considered cheap labour. For many kinds of manual field work, the contract prices are not much cheaper than they are in this country. When I first went out to Madras, I had to pay five rupees an acre for cutting grass that could have been cut in

this country for 3s. 6d. an acre. And, for subsoil draining, the cost per acre was nearly as great as I have paid in Essex. For ploughing with the heavy plough before referred to, the people frequently pay from 5 to 7 rupees per acre. The cost of thrashing grain is less per bushel in this country than in Madras. Other illustrations could readily be afforded. If the low price of days' labour was the bar to the introduction of improved implements and machines some suppose it to be, we would expect to find, in these districts in which labour is nearly 50 per cent. higher than the average of the province, some appreciation of labour-saving implements and machines, but no such evidence is forthcoming.

The general poverty of the people has also been advanced, as showing the hopelessness of attempting to introduce improved implements and machines into the country. Though native farmers generally are certainly miserably poor, there are thousands and tens of thousands who, comparatively speaking, are well off, and who could readily raise the means needed for purchasing any improved implement or machine that they might require.

Speaking generally, the so-called plough—for as it neither lifts nor turns the soil it should be called a cultivator rather than a plough—is the only implement the native farmer uses in the tillage of his soil. In some places a rough harrow is made use of, and in other places they use a rude description of cultivator. Rollers are not employed; if clods are to be broken down, short clubs are used for the purpose. The tillage is universally shallow, and is obtained by going over and over the land with the plough; sometimes this is done ten or twelve times. Under ordinary circumstances two operations with an ordinary mould-board plough, and one operation with a harrow, would produce a much better tilth. It has been proved again and again that while nearly 600 cubic yards of soil can be moved and turned over by an improved plough for an expenditure of one rupee, equally good work could not be done at a less cost than two rupees by a country plough.

We have introduced small improved ploughs from this country, from Sweden, from the United States, and elsewhere, and have made various improvements in the plough of the country. These ploughs have been worked by ordinary ploughmen and cattle in public, in most of the agricultural districts, on different kinds of soil, and under widely different conditions, and all have been worked regularly at Saidapet for lengthened periods, and their work and durability tested. Alterations and improvements suggested by this experience have been made, and several of the ploughs thus improved and adapted are now regularly made and sold by local manufacturers, and are in fair demand. Some of these ploughs are made of wood, and have iron working parts. Others are made entirely of iron. The difficulty of getting repairs done to these ploughs in the agricultural districts has not yet been satisfactorily overcome, but further efforts are being made in this direction, some village blacksmiths and carpenters having been trained at Saidapet. It is a common error to believe that improved ploughs of European pattern are much heavier to work than the ordinary native implement. The dead weight of the latter is certainly, on the average, only about half that of the best description of improved ploughs; and of course in cases where the plough must be carried to or from the field on the shoulders of the ploughman, its weight is a great consideration, but it is far from being necessary, in the majority of cases, to convey the plough in this manner. But, after all, the dead weight of the implements is a minor matter than the draught of the implement when working. In testing, by means of the dynometer, the draught of country ploughs when at work, I have sometimes found the draught excessively heavy for the work being performed. In one instance of many, I found the draught of a native plough nearly 400 pounds, when doing only a third of the work that an improved plough near was doing with an expenditure of less draught.

I would like to have added some remarks about improvements made in the minor implements and tools of native husbandry, for we have given more attention to these, than to the larger implements and machines used in more advanced countries, believing that the work of reform must be done gradually, beginning first with the tools and implements already in use. But much attention has been given to water-raising apparatus of all kinds, driven by wind, animal power, and by steam, and to implements and machines suited for the use of the larger and more wealthy farmers.

I must hasten to my last subject—

Improvement of Farm Stock.

The horse is not used in native agriculture. Horse-breeding has now been almost entirely abandoned in South India, the people say

because there is no longer any good grazing land. It is certainly a fact that about 30 or 40 years ago horses were bred in the province suited for army purposes, and that now no such horses can be obtained. I have already pointed out that the province is specially rich in indigenous cereal and pulse crops that will yield excellent fodder, some of which would be well suited for horses. In pony and mule-breeding something is being done, a few good pony stallions and ass stallions having been imported. But, nothing really worthy of the State has yet been attempted in this direction. The army is now supplied chiefly by horses imported from the Australian colonies.

Cattle are invariably employed, both for farm work and for road traffic. The cattle of the province generally are very inferior; but there are good breeds in one or two districts, the influence of which has extended to the country around. Of these, the Nellore and the Mysore are by far the best. But these do not constitute 10 per cent. of the cattle stock of the province. As a general rule, no care whatever is exercised in breeding. Young and undeveloped animals, those that are deformed and unsound, old and unhealthy animals, animals with various tendencies, as dairy stock, draught stock, &c., are all allowed to breed together without restriction. The consequence of this neglect can readily be imagined, for even the restraining influences met with in wild herds are either altogether absent or are exercised only to a very limited extent.

Cattle are not fattened for slaughter, as in this country. The demand for beef, for the use of the Mahomedan and European population, is met by the slaughter of old, maimed, and sick bullocks, unfitted for any work, and old and barren cows. Such animals can generally be got for a few rupees; indeed, they are not unfrequently turned out to die. I have fattened good healthy cattle specially for slaughter, that yielded excellent beef, at a cost of about 2½ annas per pound.

As a general rule, the non-irrigated districts contain the best races of cattle. Those in the irrigated districts are almost invariably wretched in the extreme, but are more numerous. In the non-irrigated districts the tillage is heavier, and larger cattle are in demand, but the food, in the shape of grass and straw, is undoubtedly better, while the other produce of the land, such as cotton-seed, pulse and corn, affords a more nutritious cattle food than rice, the only crop produced on the irrigated land.

Agricultural shows have done some good in encouraging care in cattle-breeding. When first instituted, the people generally refused to exhibit their cattle, being suspicious that the object of Government in offering prizes had something to do with increased taxation. But gradually, at each successive show, this mistrust was diminished, and in one district at least —Nellore—in which a number of these shows have been held, the people appear to have now confidence in the motives of the Government, holding the shows, and exhibit their cattle freely. Much good has been done to the Nellore breed by these shows, in encouraging attempts to improve the stock, and in making the general excellencies of the breed more widely known.

Milk is used by all classes of the population. We might expect, therefore, that dairy farming would receive some attention, but if there is one branch of farming more neglected than another, it is certainly dairy farming. There are no specially reared races of dairy stock, and the milch cows are subjected to no special management, while the treatment the milk undergoes is always highly unsatisfactory. An ordinary milch cow, in full milk, seldom gives more than three to four pints, and gives milk for only about six months. Fortunately the cattle have not all equally degenerated. In some localities, more especially the thinly-populated jungly tracts, where grass is more abundant, fairly good cows may occasionally be obtained, which, with good feeding and management, sometimes turn out useful dairy stock. Such animals put to bulls equally carefully selected produce stock suited as the foundation of a dairy race; but progress in this way is slow and frequently disappointing, from the many uncertainties that attend the enterprise.

To meet the urgent demand for dairy stock, chiefly on the part of the European residents, good bulls have been imported into the province, and have been put to selected cows of the better native races, with, on the whole, very satisfactory results. These bulls were obtained from the Australian Colonies and from Aden. The former were Devons, Shorthorns, Kerrys, Alderneys, and others; while those obtained from Aden were all of the breed known by that name. Of the European breeds, my experience shows that the Devons proved the most useful, and this breed it will be remembered is suited alike for the dairy and for draught purposes, a

combination of merits specially desirable to secure in Indian stock.

I have never seen any reason to believe that the half-bred animals suffered in the hot season to a greater extent than animals of pure native races. I had a half-bred Devon cow for over 10 years, at Saidapet, that was grazed with native stock, and was managed in the same way. She enjoyed perfect health and produced a calf nearly every year, while her yield of milk was more than four times as large as that of the ordinary country cow, and her milking period was at least twice the length. Other experience with the same cross has proved equally satisfactory. It must, however, be evident that for many reasons it is neither desirable, nor possible if desirable, to look to bulls of European breed for improving native races of dairy stock, though on the hills, and in some other parts of the province, much good might be done in this way.

The Aden breed, to which I have briefly referred, more closely resembles the native races of the province, in size and general characteristics, and comes from a country in which the agricultural conditions do not differ widely from those of Madras. It is a humped race, and is almost as well suited for draught as for dairy purposes. The imported stock have succeeded admirably at Saidapet, and have become regularily established, one cow of the breed, when over ten years of age, gave in an average milking period, six times her live weight of milk, 17 pints of which gave on the average one pound of butter.

There are several indigenous breeds of sheep in the province, though none possess any special excellence. As a rule, when properly fattened, they afford good mutton, but they fatten very slowly, and do not give a good return for their food. An average sized three year old sheep of one of the best breeds will weigh, when fat, about 50 pounds live weight, that is, about one-fourth the weight of a fat sheep of one of the ordinary breeds in this country. None of these native breeds are wool producers. A yield of one pound per head of wool is above rather than below the average yield. The wool is usually largely mixed with hair, and very coarse. Except the Brahmin, all people of South India are mutton eaters when they can afford to buy it.

Much attention has been given to the improvement of the sheep stock of the country, both by means of selection, and by the introduction of imported animals of good breeds. Merino, South Down, and others, have been imported from Australia, where the breeds had undergone partial acclimatisation to a hot climate. Also Asiatic breeds from Bengal and China.

At Saidapet considerable success has attended the experiments by selection with native breeds. The yield of wool has increased from below one pound per head to nearly four pounds per head. The value of the wool has increased to fully the same extent; while the animals now reach maturity earlier, and fatten on less food.

There are many subjects of interest on which I have said nothing, and much more might be said on some of the subjects to which I have only briefly alluded. But I have already made an unusual demand on your time and attention, and must bring my remarks to a close.

Extracts from the "Manual of Administration, Madras Presidency."

RYOTWARRY TENURE.

"A ryotwarry settlement means the division of all arable land, whether cultivated or waste, into blocks or lots, the assessment of each block at a fixed rate for a term of years, and the exaction of revenue from each occupant according to the acres of land thus assessed which he occupies.

"That area may either remain constant, or may be varied from year to year at the occupant's pleasure by the relinquishment of old blocks or the occupation of new.

"The occupier holds under an annual lease from Government.

"The term of the ryotwarry settlement is, according to the present intentions of Government, thirty years from the date of the completion of each particular local settlement, at the end of which time not only the commutation money rates, but the grain values themselves have assigned to the land, are liable to revision. The Government reserve the right, that is to say, to derive benefit in the future from a share of the increased value conferred on the land by improved administration, the construction of public works, especially works of irrigation and railways, and the improved prices of agricultural produce.

"Though the State has the right to fix the land tax (elsewhere called rent) at its discretion, it does so in accordance with certain principles. In ryotwarry, it is held that (with a few exceptions) its proper amount is half the value of the net produce of the land, after the expenses of cultivation have been deducted from the gross produce.

"No such title deed is, however, given to ryots holding under the ryotwarry tenure, and they are left to make their own arrangements as to creating a title when they dispose of their land by private transaction.

"When first a ryot is put into the possession of land he is furnished with a document called a puttah. But this is liable to revision annually. . . . In the law courts, however, a puttah is very weak evidence to prove possession. The law courts have recently declined to recognise the proprietary rights evidenced by the power to create an easement against Government in ryotwarry holders.

"Briefly speaking, the lands are first classified according to their soils, and the grain value of each soil are determined by actual experiments taken over a large area, and with the help of other extraneous information. From the grain value thus determined, a deduction is made on account of unfavourable seasons and cultivation expenses, and the remainder, which represents the net produce, is valued. From this half a small deduction is again made on account of unprofitable areas, and the remainder is commuted into money at a fixed rate, which represents the average value of the grain for a series of years."

DISCUSSION.

Major-Gen. MICHAEL, C.S.I., said, in the early part of the paper, reference was made to the Saidapet experimental farm, started by the late Sir William Denison, and as his own name was mentioned in connection with it, he might be permitted to make a few remarks. For many years he was a working member of the committee, and latterly the honorary secretary, so that he was in a position to endorse what had been said of the uphill work generally experienced in starting any such new operations in a country like India. The committee formed by Sir William Denison consisted of a few gentlemen who were stationed at Madras at the time, and as they all had official duties to perform, of course they could only devote a portion of their leisure time to the management of the farm. After a few years, when the scheme had been given a fair start, the committee asked the Madras Government to obtain the services of an able professional agriculturist, who would be able to bring more advanced and scientific knowledge to bear on the subject than they could aspire to. As the result of this recommendation, Mr. Robertson was sent out from England, and the farm was handed over to him. Mr. Robertson had already stated how from that small beginning not only had agricultural tuition made great strides throughout the Madras Presidency and India generally, but it had developed into an agricultural college, of which Mr. Robertson was now the principal. The Government records and the college calendar showed that a very large number of young natives had profited largely from the tuition given at the college, and although he was told that opinion differed in India as to the utility of experimental farms and agricultural tuition generally, he could not doubt but that the result would directly or indirectly benefit the State. Mr. Robertson had stated that improved agricultural implements had also been introduced, among others, American and Swedish ploughs. This was particularly interesting to him (Gen. Michael) personally, as he was the first to introduce light iron ploughs. While acting as Commissioner for India at the Vienna Exhibition of 1873, he was also British Juror for agricultural machinery and implements, and seeing remarkably light and cheap iron ploughs among the Swedish exhibits, he thought they might suit India, and recommended their trial in Madras. Not only were these ploughs now largely used in Madras, but they were manufactured there. This was a clear case in point that the native ryot had accepted and recognised the advantage of superior tillage. The necessity for improved agricultural implements had been recognised in almost every country. He instanced Hungary and the Danubian Principalities, and he hoped it would be the same with India. Agricultural exhibitions, in his opinion, tended to the education of the masses, and to wholesome rivalry.

Mr. W. S. SETON-KARR had some little hesitation in criticising this paper after the exhaustive manner in which Mr. Robertson had dealt with his subject. He regretted to find that, after twenty years' work, the Saidapet farm had been partially closed, although doubtless during this time it had done excellent work. He thought the reader of the paper had hardly done justice to the qualities which native cultitivators displayed, for when he (Mr. Seton-Karr) first took up this subject he found that he had a great deal to learn, and that the Bengal ryots could teach him quite as much as he could teach them. The ryot knew the lay of the land, he was acquainted with irrigation, knew when to sow and when to reap, and it was only from poverty that he did not use manure. The best manure was cow dung, but it was found to be too valuable for fuel to be commonly used as a manure. Among the best things cultivated in Bengal was sugar-cane and the date-palm, and the date cultivation had been largely introduced into Lower Bengal by native tenant-proprietors. He did not in the least undervalue the various experiments which the Indian Government had been making in India to improve agriculture, but it was generally found that the first attempts were all failures, and after perseverance success was achieved. He had known signal failures in the cultivation of tobacco and wheat, but in the second and third year the efforts were rewarded with some success. Agricultural shows were pleasant things in their way, but their value was rather of a social and political kind, because they brought various classes together, and might excite a spirit of emulation. Some agricultural associations had been started in Upper India, which were entirely managed by natives. The expense of a Directorship of Agriculture had not exceeded £10,000 in a year, and one snch department was carried on most effectively for £5,000. If the higher class of natives could be induced to take up the subject, there was no doubt that improved agriculture

would spread in various provinces of India. The Chairman had made some excellent remarks with regard to wheat, but much wheat was not grown in Madras; the great wheat-producing provinces were the Punjaub, the North-Western Provinces, parts of Bombay and Scinde, and Behar, and the Central Provinces. He had been for many years in Lower Bengal, but he did not recollect having seen there one acre of wheat. He hoped the experiments now being conducted would be continued, and believed that if those who had to do with the tenant-proprietors examined into the matter, they would have a higher opinion of them than was generally entertained.

General MACDONALD said it happened that he, during the period when Mr. Robertson was in Madras, presided over the office of public instruction, and it was partly his duty to endeavour to do what he could to help to advance the cause of agriculture. With the view of doing this, he introduced it as a subject for which grants were to be given. It was also introduced into some of the higher examinations. He was also officially connected with the School of Agriculture, at the head of which Mr. Robertson then was. Everyone knew that he had considerable difficulties to contend with, and did not receive the amount of official support to which he was entitled. Many of the students who came to the college were from the Bombay Presidency, and Sir Richard Temple, who was then Governor of Bombay, took the opportunity of obtaining Mr. Robertson's help to establish a school at Poonah, which had been attended with considerable success. He thought Mr. Seton-Karr was mistaken in saying that much wheat was not grown in Madras.

Mr. THOMAS CHRISTY said it had fallen to his lot, during the last few years, to introduce the native products of India into this country, and although Mr. Robertson had only alluded to coffee and tobacco, and a few other things, he thought that in a place like India, where the natives were so well up in agriculture, that drugs, for which there was a large demand in Europe, should be cultivated. If the Botanical Society, by means of exhibitions, would show the natives the value of different crops, with a little assistance they could be cultivated. There were very many important medicinal roots and trees which could be extensively cultivated in India, but owing to the want of knowledge they were not cultivated to the extent to which they might be. The process of drying and packing was of great importance, for at the time the foliage yielded the best results it might be the wet monsoon. Then the herbs wanted treating in drying machines or heated chambers, and the difference in value amply rewarded the extra expense. The kola had been introduced into India, and the natives were very fond of it; a chocolate was produced from the nut which was of such a sustaining nature that the Portuguese Government had lately sent to procure a supply for use in their expedition into Africa. The Mhowa could also be obtained in India, and as it might be used in England and other places, he suggested that its cultivation should be largely extended. He was frequently asked to send plants to India, and when they arrived it was found that they already existed there. On one occasion the Government sent to Egypt for a supply of dates, and after obtaining them they discovered that dates were grown in India. The efforts of the Government should not be directed solely to the grain crops. He was sorry to hear that the farm had been shut up, and hoped that the Government would be induced to re-open it, and give it a liberal support.

Mr. ROGERS observed that the Mhowa or Mhowra tree was grown extensively in some parts of India, and they might depend on it that if it was found to be of any use, it would be cultivated elsewhere also. The date palm was also grown in Bombay, but there also, as Mr. Seton-Karr had said was the case in Bengal, the fruit never came to perfection; the tree was only used for its juice. He thought Mr. Robertson had hardly given sufficient credit to the native agriculturist, for where the profit of any particular kind of produce was proved to him he did not hesitate to adopt it. For instance, in the Southern Mahratta country, New Orleans cotton had completely supplanted the native varieties; and in Khándesh, where Mr. Ashburner showed him the snperiority of the Berar cotton over that of the country, the latter had been exterminated. It had also been said that rotation of crops was not known to the native agriculturist. Such was not the case in the Bombay Presidency, where rotation of crops was very extensively practised. Cotton was never sown year after year, except during the American war, when the price rose very much, and people had been known to pick out the cotton with which cushions had been stuffed in order to sell it. The practice was to sow cotton in regular rotation with wheat and other grains, and the same remark applied with regard to sugar-cane. He fully agreed with Mr. Seton-Karr that if an exotic plant were introduced into a country and did not succeed at first, it might get acclimatised, in the second generation. Mr. Robertson had said that grass was only grown upon land which had been relinquished, but that was not entirely the case, for in many parts of Bombay large areas were set aside for the growth of grass, and the land sold for much more than the assessment would be, although it was true that land was not sown with grass seed as it was in England. He would like to know Mr. Robertson's opinion on deep ploughing. His own theory was that in most cases it brought up the fertilising properties of the soil to the surface, and these were evaporated by the tropical sun pouring down upon them. He would be glad to see bones used as manure in India, as an immense quantity was to be found lying outside each

village. No doubt the reason why they were not used was on account of caste, as the people believed they would defile themselves and their fields by using bones. There was a great deal more to be said for the natives and their system of agriculture than Mr. Robertson had given them credit for.

Pandit SRILAL, who had lately completed his course at Cirencester College, and had five years' practical experience in India as the secretary of the Bijnor Agricultural Institution, said that he should like to offer a few remarks, and in doing so, he should speak the sentiments of the landlords and tenants. They recognised the great importance of agricultural improvement, but at the same time they were convinced that agricultural improvement on any extensive scale was next to impossible unless the Government also recognised its proper duty in this direction. The policy of her Majesty's Government was based on the assumption that it was solely the duty of the landlord and tenant to introduce improved methods of agriculture, and that the proper function of the State was only to advise and suggest measures. This was hardly consistent with the character of the State as the chief landlord in India, especially when we took into consideration that the greatest item of revenue was derived by the Government from this source, for it would be next to impossible to carry on the administration of that country were it not for this great resource. There were some difficulties in the way of landlords which proved a bar to the introduction of agricultural reform, such as the arbitrary character of the revenue settlements, which were subject to periodical revision. Even the best of landlords would let their lands deteriorate as the time for revision approached, as they apprehended that any improvement effected at their own cost would be more than absorbed by the consequently increased demands of the Government. Agriculture there might be improved by extending irrigation, by the improvement in the breed of cattle, by taking proper measures for the prevention of cattle disease, and by the introduction of better seeds and improved implements. The only implement of a European character which had, up to the present, found anything like general favour with cultivators, was the Beheea sugar-cane mill. The mill was being sold in thousands, and as secretary of the above society he purchased no less than 1,000 of them, the price being about ninety rupees each. The number of this machine which had been sold was evidence that the cultivators never hesitated to adopt improved processes, provided they were within their means, and at the same time profitable. Many attempts had been made in Northern India to introduce an improved plough, but up to the present these attempts had either been failures, or only partially successful. He thought the time had arrived when the Government of India should move provincial governments to appoint local committees, or to depute special officers to consult with the local authorities, and intelligent zemindars, as to what could be done to forward the cause of agriculture.

Mr. ROGERS pointed out that the law, at all events in Bombay, expressly forbade the assessment being raised on account of improvements made with tenants' capital.

The CHAIRMAN said he had been much struck by the remarks which fell from the native gentleman who had spoken with a thorough knowledge of the feelings of his own countrymen. He agreed that the agriculture of India was in many places extremely good, and especially in the Punjaub, where he noticed very good management. It had been stated that cow dung was too valuable as fuel to be used for manure, but he recollected a very curious experiment, made by Mr. Robertson, for the purpose of determining whether cow dung was better than ashes; a certain quantity of seed was placed in ground manured with the dung, and a similar quantity with the ashes of the same weight of dung; the ashes produced the better crop of the two. If that really proved to be the fact, then the natives were using, with the greatest possible economy, the dung for fuel, and the ashes for manure. In conclusion, he begged to propose a cordial vote of thanks to Mr. Robertson for his interesting paper.

Mr. ROBERTSON said that the experiment referred to by the Chairman was continued for a second year with an entirely different result. He pointed out that the organic matter of the manure is frequently much more valuable than the inorganic portion. In reply to Mr. Rogers, he said that deep ploughing was always beneficial when the soil was fitted for it. With regard to the Saidapet farm, he was happy to inform the meeting that this farm was now attached to the Agricultural College and doing good work; but, instead of being connected with the Board of Revenue, it is now under the general control of the Educational Department. He said that it would have afforded him great pleasure indeed had he been able to say more in favour of native agriculture in Madras. In Madras there were some 20,000 acres of land under wheat, but chiefly only very inferior kinds. With regard to the remarks as to the rotation of crops, there could be no regular rotation, when every year there was 75 per cent. of one crop.

FOREIGN & COLONIAL SECTION.

Tuesday, April 17th, 1888; B. FRANCIS COBB, Treasurer of the Society, in the chair.

The paper read was—

A HUNDRED YEARS' PROGRESS IN NEW SOUTH WALES.

By W. F. Buchanan, J.P.

Introduction.

With regard to the settlement and progress of the Australian Colonies there is much to be said; and in order to convey a clear view of the position it is well to look back, so that a knowledge of the present may help us to forecast the future.

History of New South Wales.

Captain Cook, who sailed from England in the *Endeavour*, in 1769, put into Botany Bay on April 28, 1770, and Mr. Banks and Mr. Solander, who were with him, obtained splendid collections of botanical specimens. Hence the place was called Botany Bay, and Captain Cook took formal possession of the country for the King of Great Britain, and gave it the name of New South Wales. He chose this designation because he saw in the coast-line a resemblance to South Wales. He saw an opening in the land northward, called it Port Jackson, and passed on. On Cook's return to England he described the country as full of beauty and promise.

The British colonies of the American continent having, in 1776, declared their independence of the mother country, under the name of the United States, they were no longer available as the receptacles for English exiles. The gaols of England were crowded, so the news brought by Cook was welcome, and Viscount Sydney determined to send a batch of convicts there.

In May, 1787, a fleet was ready to sail. It consisted of the *Sirius*, its tender the *Supply*, six transports for the convicts, and three store ships. The first batch of convicts numbered 600 men and 250 women; 200 soldiers were sent to guard them. The leaders in command were:—Captain Arthur Phillip, Governor; Captain Hunter, second in command; and Mr. Collins, Judge-Advocate, who was to preside in the military courts. After a voyage of eight months the vessels arrived in succession, on the 18th, 19th, and 20th January, 1788, and anchored in Botany Bay, many of the convicts having died from disease and confinement.

Botany Bay being found too shallow and open for the fleet, Captain Phillip, therefore, with three boats, went round about ten miles, to Port Jackson, when his delighted eyes rested on that harbour, which is one of the most extensive, beautiful, and perfect in the world. Capt. Phillip explored these lovely waters, with the numerous bays and islands, and selected a place for settlement, which he called Sydney Cove; the water being deep, so that the vessels could lie alongside, the erection of a wharf was unnecessary. A small crystal stream emptied itself close by, which was afterwards known as the Sank Stream.

On the 26th January the ships were brought round from Botany Bay, and on February 7th the Governor assembled all the ships' companies, and in their presence read his Commission, and thus performed the first official act of colonial history.

In order to bring the early days of Australia vividly before you, I make some quotations from early history. Twenty years after the landing of Captain Phillip with the first batch of exiles, numbering all told about 1,000, the population reached to about 10,000. For forty-one years New South Wales was the only centre of colonial civilisation, and it was about forty years after the foundation of that colony that Western Australia was founded. In 1856 (fifty-eight years after its foundation), when we first obtained our present constitution through the able efforts of Mr. W. C. Wentworth, the population was only 286,873. Last year—thirty years later—the population of New South Wales was 1,044,000; and at the close of last year the shipping of New South Wales amounted to 11,287,485 tons, and its value £2,265,000. At present the population of Australia is 3,500,000.

From a calculation which may be assumed to be near the mark, at the end of another generation, about the year 1992, the population of the Australias is not likely to be short of some 10,000,000 or 12,000,000.

Sir Henry Parkes, in his speech at the centennial banquet, said that it was his "belief that at the end of another 100 years the population of the Australian colonies would reach 60,000,000." Quoting his words still further, he says:—"Talk of the growth of America with her 55,000,000 of population of to-day, including her negro population, the conditions of life are so favourable here, the conditions for the propagation of a race are so favourable, that we shall show an increase of population which has never been seen in any other part of the world."

I will now take the official figures published by the Government statist, which applies for the most part to 1886. Some of the returns overlap 1887.

The population of New South Wales at the end of 1860 was 348,546. At the end of 1886 the number was 1,001,966; six months later it was 1,022,769. The population of Australia for 1886 was 3,426,562.

Births, deaths, and marriages in 1860 were severally 14,233, 6,562, and 2,945. In 1886 they were 36,284, 14,587, and 7,811.

Arrivals by sea in 1886 were 23,031, and in 1887, 78,388. Departures were the first year 6,847; in 1886, 41,896.

In 1861 schools numbered 798, with 34,767 pupils. They increased in 1886 to 2,833, with 226,860 scholars.

In 1860 there were only 70 miles of railway open for traffic; their net earnings were £11,841, and the capital invested on lines open £1,422,672. In the year 1886 1,971 miles were open for traffic; net earnings amounted to £667,078. The expended capital on lines open was £24,079,555.

Telegraphs date back only to 1861. There were in that year 1,616 miles, and the number of telegrams was 74,204. In the year 1886 we had 20,797 miles of wire, and sent and received 2,661,126 telegrams.

In 1886 the post-offices numbered 287, and the letters, newspapers, and packets severally 4,230,761, 3,668,783, and 83,736. In 1887 the post-offices were 1,157, and letters, newspapers, and packets respectively 42,849,500, 29,932, and 4,848,800.

Manufactures and works numbered 567 in 1860; the number in 1886 was 3,694, employing 45,783 hands.

There were 260,798 acres under crop in 1860, and 972,496 acres in 1886.

The return of live stock in 1860 was—horses, 25,497; horned cattle, 2,408,586; sheep, 6,119,163; pigs, 180,662. The figures in 1886 were—horses, 361,663; cattle, 1,367,844; sheep, 39,169,304; pigs, 209,576.

Coal valued at £226,493 was raised in 1860, the quantity being 368,862 tons. In 1886 the quantity was 2,830,175 tons, and the value £1,363,164.

In 1860 there were 12,809,362 lbs. wool exported, of the value of £1,123,699. The quantity in 1886 was 173,985,640 lbs., valued at £7,028,596.

In the interval between 1862 and 1886 34,000,000 acres of land were sold conditionally and otherwise, the price obtained being £38,000,000. There remained at the end of 1886 a balance of £12,000,000 due on conditional purchases. The area of land under pastoral occupation during 1886 was 142,927,360 acres, yielding as rent £304,244, under the old scale of assessment.

The results of the cultivation of land to March, 1887, were as follows:—

Wheat......	5,868,844	bushels	..	£953,688 value.
Maize	3,825,146	,,	..	525,958 ,,
Barley......	132,949	,,	..	18,836 ,,
Oats	600,892	,,	..	52,578 ,,
Other Grain .	22,907	,,	..	17,151 ,,
Wheaten Hay	109,851	tons	..	357,016 ,,
Oaten Hay ..	182,921	,,	..	777,414 ,,
Barley Hay..	4,388	,,	..	14,261 ,,
Leaves and Grass	52,738	,,	..	131,845 ,,
Green food for Cattle	,,	,,	..	84,200 ,,
Potatoes	45,803	tons	..	103,057 ,,
Sugar-cane ..	167,959	,,	..	98,676 ,,
Tobacco	13,642	cwt.	..	51,157 ,,
Grapes for Wine	602,660	gallons	..	120,761 ,,
Grapes for Table	1,945	tons	..	45,221 ,,
Oranges	6,376,861	dozen	..	66,426 ,,
Other fruits and garden produce			..	372,100 ,,
Minor crops				153,300 ,,
The total value was............				£3,943,645

In 1861, the number of vessels and their tonnage were—inwards, 1,424 ships, 427,835 tons; outwards, 1,438 ships, 431,484 tons. In 1886, the figures were—inwards, 2,684 vessels, 2,114,618 tons; outwards, 2,755 vessels, 2,143,986 tons.

In 1860, the total value of imports and exports was £7,519,285 and £5,072,020. The figures for 1886 were as follows:—Imports, £20,973,548; exports, £15,556,213.

The public debt in 1860 was £38,830,230. In 1886 it had increased to £41,034,249.

The revenue in 1860 was £1,308,925, and the expenditure £1,321,724. In 1886, the revenue was £7,594,301, and the outlay £9,078,869. Coin in circulation in 1860 amounted to £2,946,613, and the deposits in banks to £5,721,690; the figures for 1886 were £7,806,646 and £31,933,056 respectively. At the close of 1886, the public and private wealth of the colony of New South Wales was estimated at £521,000,000. The public wealth, which consisted of railways, public works, unsold crown lands, municipal property and works, amounted to £175,128,000; and the private wealth, which embraced land, houses, permanent improvements, stock, personal property, machinery, coin, merchandise, shipping, was estimated at £346,250,000.

Of the early settlers of Australia, generation after generation have gone, and of those who landed with Governor Phillip none remain, though many passed away at ages surpassing the term usually allotted to man.

The few observations I can make on this head are the result of long residence in Australia, and of acquaintance with some who assisted in the task of controlling men and subduing the earth.

My father, an officer of the Imperial army, and the son of one who, with our family, emigrated to New South Wales in 1836, had to deal with numbers of convict servants, and I very early in life had the responsibility of such control, together with the management of stations and stock, under all the contingencies of pioneering in a land as yet almost untrodden by the footprint of the white man.

As a resident from time to time in the metropolis, and far away in the unsubdued wilds, encountering all the difficulties of transit, and the dealing with refractory servants, as well as that of large tribes of wild blacks, and as a magistrate of the territory of New South Wales since 1857, and having continued intercourse with official departments, I have been granted a means of insight into departmental influences on the progression of the country, and my pastoral and pioneering pursuits, together with gold-mining experiences, naturally threw me amongst all sorts and conditions of men. Even up to the present hour my interests have not ceased in the working up and development of the great unknown lands of Australia. Thus, from the varied personal experiences that few can lay claim to, it is natural that I should understand and be conversant with the rise and progress of colonisation in Australia.

The day has now arrived when men will be glad to know how the early colonizers lived and moved, and by what means. Though but a century old, Australia is already one of the brightest gems in the British crown.

In order to fix your attention on this absorbing subject, I must direct your notice to the map of Australia, whereon I shall endeavour to explain where and how colonization began, and how and by what means it has extended to the present time. It was on the 26th of January, 1788, that Governor Phillip planted the Union Jack on Australian soil, proclaiming it a British possession. For some years the history of the Colony was that of a penal depôt, and though its Government gradually improved, it is better that details should be buried in the past. Suffice it to say that, heartrending as the sufferings of many may have been, under such strict prison discipline as was then enforced—yet bad as they were, they laid the foundation of its future greatness.

The history of the country for a time showed a slow but steady progress, and by the pioneering courage of its early settlers its resources began to slowly develop.

Sydney ("Port Jackson" as it was then called) is banked up, or rather hemmed in, by an impenetrable mass of sandstone range of nearly 100 miles in extent before good country is reached. This at that time stood as a barrier to all exploration, and for some time the secrets of the then great unknown land remained mystified in various conjectures. It was then supposed to be a barren, desolate wilderness, but the British spirit of adventure and enterprise surmounted all barriers, and at length opened up the magnificence of a rich, luxuriant interior. Before, however, this was accomplished, I must take you back to an incident of exploration within what is now the metropolitan district.

At this time the Government were the sole owners of the only cattle in the country, which were reared from a small herd in and about Port Jackson. The herd naturally increased, and extended their travels for food. They were in charge of what we call stock-men, who looked after them altogether on foot; and there being no fences or aught to restrain the cattle within bounds, as they increased in numbers it became necessary to extend the area for their pasture. A small lot escaped at last, or perhaps were cut off by the blacks, and so frightened further afield. The caretakers were severely punished for losing the cattle, and all trace of their whereabouts was lost. Some few years after, a prisoner who took to the bush got away amongst the blacks, into a district some forty miles from Sydney, where he discovered the lost cattle, largely increased in number, sleek, fat, and luxuriating in rich hills and dales of magnificent pasture. He managed to convey his fortuitous discovery to head-quarters, and as a reward for his good luck received a pardon. This beautiful country was in consequence called the "cow pastures." It is now known as the beautiful valley of the "Nepean," in the Camden district. Here the fertile property of the late Sir William McArthur is situate, and to this gentleman the colonies are indebted for the pure Merino sheep. The purity and culture of those sheep

to the present day are kept intact by many breeders, without cross, having been to a great extent bred in, and it is to these flocks we still fall back to keep up the prestige of our Australian Merino.

It was in 1803 that Captain Macarthur, a retired officer of the New South Wales corps, was on a visit to England. On surrendering his commission, being struck with the suitableness of the climate and pasture for growing wool, he obtained a grant of land. His first attempt with Dutch sheep from the Cape, failed; but when in England he had an interview with King George III., whom he interested in his project. The king, fortunately, had received from Spain a present of merino sheep, and he generously gave to Mr. Macarthur a selection from this flock. The sheep throve on a grant of 10,000 acres made by Governor King to Mr. Macarthur; and thus at Camden was laid the foundation of that wool-growing industry which has proved so valuable, and that above all things has built up the wealth of Australia.

On the discovery of a track over this coast-range barrier from the Nepean River, the Lapstone range was ascended till an altitude of ver 4,000 feet, at and about Mount Victoria, was reached, thence the track lay over a densely-timbered and precipitous country, rich in its overgrown foliage, and gorgeous in its ever-flowering shrubs, and the home of one of the emblems of Australia, "the gorgeous, brilliant, and one of the most beautiful of all flowers, the stately waratah," visible from hillside to hillside, towering above its compeers.

It is over those deep ravines and mountain sides, and along sandstone cliffs of hundreds of perpendicular feet in depth, after zigzagging to gain the summit of the range, that our great western rail traffic carries the wealth of the interior to the warehouses of Sydney.

The railway system has so extended that Sydney is to-day in direct communication with Adelaide, Melbourne, and Brisbane, and a continuous line of about 2,000 miles in length running for the most part through fertile, beautiful, and productive districts, connects the four great Australian colonies.

Agriculture.

I am not so hopeful on this head, from the fact that owing to our greater distance from the great consuming mart, England, the Continental and American competition is too keen for us, as well as ruinous to the great agricultural interests of England. This applies to your meat supply as well as ours. The only solution I can offer for this is a free-trade policy on reciprocal terms, throughout the British Empire, with an equivalent duty on all foreign produce and manufactures such as we produce from all raw material that we can supply in superabundance, but that such raw material that we do not produce, and which we require for our manufacturing industries, should come to us free of duty. Thus we should conserve to ourselves the means of self-support and self-reliance.

No country in the world produces finer corn than New South Wales, or more prolific vintages. Were a free trade reciprocity between Great Britain, India, and the Colonies introduced, with a small protective tariff levied on all foreign produce, the Empire would become self-supporting and independent of a foreign supply, which England cannot now do without; there are conditions under which England might be awkwardly situated, dependent as she is on a foreign supply.

This suggests the idea of Federation. The Colonies are anxious for it, but the barrier of differential duties stands in the way. Once they can arrive at a uniformity of tariff, then the Colonies will bind their interests together in mutual bonds of unity and protection. To complete this union equal tariffs should be adopted between Great Britain, her Colonies, and India, with a small protective policy on all foreign produce. This is done by all European States.

Look at the sugar bounty system, sapping as it does the productive as well as the manufacturing interest of England and the Colonies. Contrast our commercial system with that of America, and what do we find? We find that America is one of the most purely free trade countries, within herself, on the face of the earth, and, notwithstanding her extreme protective policy as against foreign produce and manufactures, she is one of the most progressive, so much so that it will be found necessary to reduce her protective tariffs; we also, in order to produce that unity of action which has made America what it is, will have to adopt a fairer system of trade with our own peoples, and through a uniformity of tariff secure that federative union that will make the great empire of England still greater.

Emigration.

Assisted emigration was liberally encouraged by our Government until lately,

when, by pressure on the part of the working classes, it was discontinued. This pressure was brought about by recent land legislation, which amended pastoral leases by extending them to fifteen, ten, and five years in their respective districts, but withdrew the right of the lessee to the value of his permanent improvements, such as the conservation of water, fencing and buildings, which now revert to the crown on the expiration of the leases. Thousands of men employed on stations and such works were discharged, since no lessee in his common sense would run into debt by laying out vast sums of money in costly improvements which he would have either to give up, or submit to the exaction of increased rents on his own capital at the end of his lease. The result was that thousands of able-bodied men were thrown at once out of employment, with no industrial occupations to fall back upon; the consequence of this policy has been the labour demonstrations you have heard so much of in Sydney, giving, as they did, colonial life a bad name, and producing a false impression in England as to our resources and as a home for your surplus population.

This brings me further afield, as to the insane class pressure as regards the introduction of emigrants, which has been strongly opposed by the working-classes, who have been pandered to by leaders of our Legislature, from their dependence on universal suffrage. But, at the same time, while the voting power is so great in the hands of those who have nothing to lose, what should influence their better judgment is a matter of simple solution. I may instance the Chinese labour question. At one time, when labour was not procurable, just after the gold discoveries, it was found desirable to introduce large numbers of Chinese, under special agreements of two to five years' service, as shepherds and assistants, but as time rolled on, and European labour became more available, the European men became discontented at the competition with the Chinese, especially in the diggings, where they congregated in large numbers under "bosses." They usually worked on what we called worked-out diggings, where they reaped large rewards from their plodding careful habits. After a while, from pressure, the several Governments put a poll-tax of £10 a head on all immigrants, thus restricting the numbers. This possibly was necessary, as they promised to over-run the country, but the point, I think, to be regretted, is that the Government of Queensland should adopt such aggressive measures against the few Chinamen remaining in their country, as indicated by the following paragraph I clipped from one of the papers:—"All the Chinese have left the Clermont Goldfield, and the warden has burnt their camps. The Chinese, now numbering 150, are camped on the outskirts of the town, and have presented a petition through the "bosses," asking for rations, or else they will starve. They also ask for railway passes to enable them to get away to other places." I also observed, in a recent number of the *Times*, a letter strongly condemning the aggressive action of the Queenslanders, and the want of the commonest courtesy of a civilised people towards an influential Commission of Chinese gentlemen sent by their Government to inquire into various matters connected with the poll-tax on their countrymen, and their commercial relations with the Colonies. I cannot refrain from commenting on such aggressive discourtesy by a Colonial Government towards a foreign neighbour with whom the Imperial Government are on the most friendly terms of commercial intercourse. Such extreme action as is being taken to expel the few Chinamen from Queensland must necessarily embarrass the amicable relationship between the Imperial Government and Peking, since the Government of Peking will scarcely analyse the relationship between the Colonies and England. The remonstrances and protests that will certainly reach Downing-street from Peking must produce a somewhat uncomfortable correspondence between the Secretary for the Colonies and Sir Samuel Griffiths.

Before the Chinamen commenced market gardening in the outlying districts, vegetables were almost unknown; through their skill and industry vegetables are abundant everywhere, and good. Extreme measures are on the cards for the complete extermination of the Celestial from Queensland. The same spirit of class legislation is cutting the ground from under the feet of the sugar planters in the northern parts of Queensland, by depriving them of labour suitable for such work, and imposing on them the necessity of dealing with a class of labour almost impossible to procure, especially at a time when it is most wanted. They are therefore subject at every moment to a demand for higher rates and to strikes, which are threatened always at the proper time when the employer must surrender or lose his crop.

Hence the great desire on the part of the Northerners seeking separation to enable them to manage their own affairs, or to allow one of the greatest industries of Australia —sugar culture—to die out. I may add that in large flourishing towns with sugar refineries and manufacturing industries, and indeed in business places of all sorts in the centres of sugar plantations, where vast sums of money had been spent, restrictive pressure of class legislation, together with the pernicious effects of the bounty system, caused vast sums of money to be lost. So much for over-legislation—it is a hobby of many of our legislators to pass a private Bill through the House, so as to have something to their credit to please their constituents and hand down to posterity.

Domestic Servants.

Domestic servants are in great demand in Australia, I mean those willing to work, owing to the fact that the native girls, as a rule, will not go out to service. If a ship-load of trained maid servants landed in Sydney to-morrow, before the week was out it would be their own fault if all were not engaged.

Men Servants.

Men servants, farm labourers, navvies, miners, and that class of able-bodied men who are willing to work are certain of ample employment at good wages. Families also of the industrial classes — such as carpenters, stonemasons, bricklayers, brickmakers, blacksmiths and such like, have ample work at good pay. All such classes, as a rule, buy from their savings allotments of land, build their own houses, save money, and become owners of property, and many, after a while, become Government contractors. There are great facilities for acquiring building land on easy deferred payments, building in the same way. The emigrant has a good open field before him anywhere in Australia.

Manufactures.

Under this head, although manufactories are in existence in New South Wales, and prosperous in some respects, I cannot point to any deserving of very favourable comment, except of the ruder class, such as brickmaking, shoemaking, tanning, fellmongering, wool scouring, sawmills, joinery, soda water and cordials, breweries, flour mills, woollen (which do not flourish), and many others of a like character. But factories of the artistic class do not progress now, such as fine wollen, silk, hosiery, lace, dyeing, gunnery, shot, powder, cutlery, the finer sorts of ironwork—of corrugated and tinning. All of a character requiring really skilled mechanics and delicate machinery have no footing, nor ever can till some stimulus is given to capital in this direction. Nor can our technical education advance without the same stimulant. We have a large rising generation with no immediate prospect of artistic culture essential to a young country. The result is that the youth—both girls and boys—of Sydney have little useful employment.

The reverse, however, is the case in Victoria. There, under a protective policy, the youths are fully employed in manufacturing industries of the finer arts. Engineering, steam, and many of the finer sorts of ironwork are carried out with credit to the country. As a matter of fact, our stores in Sydney are supplied from England—but chiefly from Victoria—with all sorts of farming machinery. The New South Wales stations are supplied with their wool presses and nearly all other machinery, such as wool-scouring plants, excavators, &c., come from Victoria.

So extreme is the free trade policy in Sydney, that if you take a carriage, dog-cart, harness, furniture, or almost any manufactured article ready for use, on landing there you pay little or no duty on them, but if you take out materials to build those things you pay duty on them.

But little or no material for carriage work or machinery, or paints, oils, or any things of that sort, nuts, bolts, screws, nails, &c.—not to speak of mechanical requirements—are manufactured. All efforts are confined to the fostering up of a merchant agency business with a view of a large shipping trade. There is one paper mill, which went to the wall, but, after being bought up at about one-tenth of its original capital, it manages to struggle on. The great effort of our free trade Government is to strangle native industries, and eke out every fraction they can from the producer; for instance, a few years ago, in an administration of Sir Henry Parkes, an attempt was made to bring an excise tax of 1d. per pound on wool, and 1s. a ton on coal. Then, again, it was tried to levy 3d. in the £ on property, yet in the face of all this, while every effort is made to tax the crown lessees, and all producers, no equivalent is sought from the consumers through the Customs, unless on what they call an *ad*

valorem system—tea, tobacco, wines, spirits, and such, which they call luxuries.

Contrast Sydney with Victoria, what do you see in the way of manufactories? Where you see one chimney stack in and about Sydney, you can see ten in and around Melbourne. You will seldom see smoke without a fire at the end of it. Go to Ballarat and you will see iron works, steam-engines, boilers, stampers, and hundreds of manufactured articles for mining, farming, &c., which will compare favourably with your works in England.

I once visited the Juvenile Technical Exhibition in Melbourne, and the variety and artistic models there would astonish you. How does all this contrast with our indebtedness and a full treasury in Victoria? All this will be questioned, but I give it from my own personal, practical observations.

Sir Henry Parkes, at some big dinner in London, has the credit of saying, in his eloquent and patriotic style of lauding up the Australian Administration, that we had nothing to learn from the old country. He could scarcely have meant all that. If he contrasted our arts, sciences, and manufactures, with the old country, it must be readily admitted that we have a vast deal to learn. So much, indeed, that I would recommend every would-be alderman—especially of our country municipalities—to do twelve months' travel over here. One thing they would learn—not to destroy all the indigenous timber trespassing on roads, streets, and other places. The great delight of Colonial municipal bodies is to wage war against any tree near a highway, and few towns in New South Wales are honoured with tree planting in the streets. In Victoria it is the reverse. Travel opens a man's heart as well as his mind.

Fine Arts.

Hitherto the fine arts have not progressed, but within the last five years a marked taste has evinced itself. The several exhibitions and the collection of some fine paintings in our art gallery has done much in developing and refining native taste; but I cannot say much for the art gallery itself. It is an ugly, unsightly, oblong square, usurping an out of the way site in the middle of our park. The temporary Technical College, where you see but few students, is likewise out of access for practical work.

The Sydney Administration have evinced strong desires from time to time to annex the rights of the people by encroachments on their small recreation-grounds. At one time it was proposed to sell Hyde-park in building lots. There is also a great desire on the part of old hands to pull down and destroy ancient landmarks, anything in the way of buildings that point to the early history of Botany Bay, Farm Cove, and the Tank Stream—notably two of the only old buildings now remaining worthy of consideration, built by the exiles, well and faithfully executed of brick and stone, and superior by far in durability to the work done now. One is Carter's Barracks, an old convict receptacle, and now the Emigration Barracks; it is a large, roomy, substantial building, well suited for the purpose. The other is the old venerable regal church of St. James; it stands opposite Carter's Barracks, at the top of King-street, next to the Supreme Court. This fine old roomy church, the oldest in the colonies, except one in Parramatta, is built in the old English style—large, substantial and solid enough to last for centuries. These fine old relics of Australia, I believe, are doomed to destruction.

Land Policy.

The land policy of New South Wales has undergone many alterations, and is a constant source of squabble. In 1861 all the previous systems were annihilated by the Land Act of that year, passed into law through the untiring efforts of Sir John Robertson. This Act gave conditional purchasers the right of selecting land anywhere on the leaseholder's ground. They could take up any permanent water frontage, perhaps the only spot where your stock watered for miles round, or any other special spot on your leasehold; this was the practice rather than the exception, and was done in order to blackmail the squatter, pound his stock the next day, or wait awhile, and either clear out for a big sum for which they could give no title, or they would bring actions against the unfortunate squatter for damages for his stock coming to water on the ground they were used to. This created two distinct classes, producing a class-feeling of antagonism which has never been wiped out, though the law has been modified by a recent Act, making it compulsory for the selector to fence his land.

By the same Act the leases were extended, and Boards of three commissioners or appraisers were appointed to each district to value and fix the rents. These valuations, however, not

pleasing the Minister for Lands, in most cases he raised the rents according to his own tastes.

The effect of the Bill of 1861 was to force the squatter to buy up all the land he could lay his hand on, and thus while many ruined themselves by borrowing money at high interest to lock up in land, others were ruined by the eyes being picked out of their leaseholds, while many succumbed to the pressure, never to recover. Yet on the whole the power to the many to procure land on easy and cheap terms has been fruitful of much good; but it is obvious to all thinking men that all this good could have been accomplished equally well without the ruin it entailed.

Our land laws are on the eve of another repeal, but what the effect of it will be must rest in the future. The system of free selection or conditional purchase is now so easy and simple, that a man or family with very moderate means can select from 40 to 2,560 acres by paying a deposit of 2s. an acre, the balance by yearly payments of 1s. an acre, including interest at 4 per cent., till all is paid, when he gets a title grant from the Crown. This assures to the careful, industrious, and persevering emigrant the certain means of independence and fortune, in a land where the hand of fellowship is extended to him, and no tongue spoken but the English language. Thousands of cows go unmilked, and the forests are full of the English bee, so that, literally, this is a land flowing with milk and honey. No man or woman need go to Australia with a failing heart. It will simply be their own fault if they do not thrive, and acquire property—live long, and die happy.

Torrens's Land Transfer Act.

Torrens's Land Transfer Act became an institution of all the Colonies, beginning in Adelaide, whence it emanated, from the late Sir Robert Torrens. Nothing could have been conceived to give such easy facilities to the purchase, transfer, and exchange of landed property. Nearly all the old titles have gone through the examiners' offices with a clear and distinct registered title, so simple and easy that you can transfer, as a whole or by subdivision, any landed or house property at a cost of about half a guinea. Well, I suppose solicitors do the most of the work. They have not lost in a professional point of view by the change, since land buying speculation is one of the great institutions of the country. It would be well worth copying in this country.

Education.

Governor Gipps, during his term of office, introduced the Irish system of education amongst the people. The system has gone on, and has been brought to as high a a state of universal perfection as that of any State in the world. The highest standard can be reached by the most humble and lowly in the land, and our university, which compares favourably with any in England as to appearance and scholastic efficiency, is open to all.

Pastoral.

I have already given authoritative statistics of the pastoral resources of the country. They go to show that the pastoral stability and future are well assured from the continued increasing manufacturing requirements of our raw material, and are not likely to decrease through foreign production, from the fact that the wool supply of the continent of Europe, the American States, and the Argentine Republic are diminishing rather than increasing, while their populations and requirements increase; this, together with the prospects of a reduction of import duties on our raw wools, will tend materially towards the increase of requirements for our colonial wools, which foreign nations can scarcely do without. Every inch of available pastoral land in New South Wales has been taken up, and is as fully stocked as it can carry under the present state of development. If, however, the leases were assured in the value of permanent improvements, the productiveness by water conservation and otherwise would very soon largely increase the produce.

I may add that not only does this not result under the present insecurity of tenure, but millions of acres are being thrown up from this cause, and especially from the arbitrary action of the Minister increasing the rents according with his own unpractical ideas, and always exceeding the assessments of the appraisers appointed for each district to take evidence on the ground, and assess accordingly.

The great efforts and object of our democratic Government have been to overweight the pastoral tenants, cut their holdings up, annex their improvements, and eke out of them every fraction they can. The last straw is almost placed on the camel's back. Now is the time, while they are in a state of transition, and vast areas of pastoral lands are being thrown on the hands of the Government, for men with small means to step in and take up those forfeitures on better terms. As a matter

of fact, squatting (pastoral occupation) is completely played out in New South Wales. All the fine old squattings are converted into freehold estates. The present policy of the Government is to retain all the crown lands as leaseholds. There they make a vital mistake. No lessee will develop that which he has not an inherent right in. Notwithstanding such barriers and exactions, the wonderful fruitfulness of the country surmounts the pressure, which falls heavily only on the large proprietors.

Your English and Scotch farmers, even with but small capital, should not miss the present chance of securing agricultural and grazing estates, while they can do so, in every district of New South Wales, under those favourable circumstances—a deposit of 2s. an acre, and the balance by yearly payments of 1s. All country in New South Wales is pastoral as well as agricultural. When the timber is too thick, it only wants ring-barking to enable the land to be covered with good pasture.

Rainfall is ample and superabundant for all requirements. Providence is most bountiful in all respects to Australia, and it requires but the careful conservation of all that we allow to go to waste three years out of four. People are erroneously led astray by newspaper reports of Australian droughts. Bad as they are, they are only local, and the great losses accruing has been brought about by the want of a provident care and by over-stocking. The over-stocking was resorted to with the owners' eyes open, in order to denude their leaseholds of herbage, for the purpose of keeping off selectors. So much for squatting in New South Wales—unless I may add that, owing to the market prices of good sheep—8s. to 15s. per head—it requires fairly large holdings to make it pay.

Young men of some practical knowledge and energy, with some of the old English pluck, not forgetting some of her stored-up capital—which, by the way, is not of much value just now in this country—should join hands of two or three, and go out to the northern territory of South Australia, or to the northern part (Kimberley) of Western Australia, where they can either buy in or take up direct from the Government large pastoral areas on liberal and easy terms, in a climate where drought can never overtake or cripple their progress; a good climate, and within easy reach of shipping ports equal to anything in the whole world—Cambridge Gulf, Victoria River, and Port Darwin. These are the only open places now in Australia where young men can do as the now old squatters did in New South Wales, Victoria, and Queensland—rough it a little, work hard, be prudent and careful, and make their pile.

The whole of Australia is suitable for cattle and horses. The herds of New South Wales are principally of the Durham (shorthorns) and Herefords, and a few Devons. In the dairy districts the Ayrshires, Alderneys, and Jerseys are on the increase. Take the cattle all round they will compare favourably with your English herd. Some of the best blood has been introduced for many years past, and now that the restrictions are removed by our Stock Protection Law, which is in force to prevent the introduction of contagious diseases, we shall be large buyers for your best sires.

Horses.

The climate and herbage of Australia produce horses equal to the best in the world, when care is taken. And now that we have such large and roomy ocean steamers as those of the Peninsular and Oriental and Orient Companies, there is no reason whatever to prevent the English cavalry being remounted from this source.

Aborigines.

I have been, accidentally and otherwise, brought in contact with the wild, or worse, the half-civilised blacks, sometimes by myself, amongst hundreds of them, and when I think of it now, at many times in great danger, but I always showed a bold, friendly front, and never pulled a trigger on one in my life, nor, to my knowledge, did anyone under my command. On one occasion, worthy of notice in this paper, I was crossing country by myself, far away from track or habitation. It set in heavy rain, such as our rainfalls mean; heavy, incessant downpour for days together, flooding the country, and rendering the soil heavy and boggy. It was my fate on this cold, wintry day, to wend my way towards a given point, by the direction of a sun I could not see, but only guess. My horses, wearied by long travel, sank to their fetlocks in the deep, black, basaltic soil of our western slopes. Night fell in, my provender was gone, but that hope and self-reliance so strong in the Australian bushman helped to give confidence to my weary horses, and we pushed on, in hopes of some cheering light ahead, from some solitary stock-hut, or shepherd's. My true and trusty companions (horses) were failing fast, tripping

and floundering through the deep soil, when they pricked up their ears at distant, unearthly sounds, and presently, on gaining the eminence of rising ground in front, saw, to our delight, numerous lights ahead. I saw at a glance the situation, and knew I was many miles from the habitation of white men. My horses felt no fear, neither did I consider the risk. The prospect of a halt for the night, and a supper on fine green food, inspired my horses with redoubled vigour, they boldly pushed on, and landed me in the middle of about 500 blacks. The blacks hearing the dull tramp of my horses, which they could not see, were on the alert, many of them with spears and other weapons in hand, but on seeing me and two companions (Acteon and Moderrideroo) I was received in their midst. Comprehending my plight, as they immediately did, and after my friendly salutation, their hearts went out in boundless hospitality. A gunnia of three sheets of bark and a camp fire was at once placed at my disposal, my horses hoppled out on the best feed, and a nice young opossum was thrown on the bright embers of a wood fire for my repast; I relished it very much, and so would you under similar conditions. Sheltered from the pitiless downpour, and with the help of an opossum rug, I slept like a Trojan. My horses were brought to camp in due time in the morning; it still rained heavily; a river in advance which I knew would be heavily flooded induced me to push on, so after about twelve miles I was just in time to cross it at swimming depth. In an hour after it became a raging torrent. All I had to give the blacks who were so kind was a little black tobacco. They like tobacco better than all else, rum next.

My experience with the blacks of Australia taught me to adopt a fearless demeanour, firmness of conduct, and, above all, that which leads men on to fortune and good fellowship, a strict and reliable obedience to your promises and engagements. All savage races view with distrust and contempt those who break faith and take advantage of them, if not, presently the retributive justice sets in, and reprisals according to their laws. The Aborigines are quick and intelligent, good copyists and mimics, and good natured; but owing to their want of foresight in the future they give themselves up to all the vices introduced by the white man, and die off. I know many districts where I have seen congregated for *corroboree* 2,000 to 3,000 blacks, where now you could not muster five to twenty. Not a single one now remains to represent Botany Bay or Port Jackson. The last of the Tasmanian black long since became extinct, and as the white man's state of civilisation extends so do the blacks decrease. Notwithstanding the efforts of missionary stations in Christianising, and teaching industrial habits, the change from their native habits will completely eliminate the whole race. In all probability before Australia marks another century the Aborigines will count with the extinct races.

Gold and Other Metals.

It was in May, 1851, when Hargraves returned from California, where he obtained a practical knowledge of gold digging, and his good fortune enabled him to lay bare the hidden riches of Ophir, near Bathurst. A few weeks after this, one goldfield after another opened up in quick succession. At this time it was all surface work, and all a man wanted was a pick, shovel, a cradle, which is like a baby's rocking-cradle, and a dipper to wash the soil through the hopper of the cradle. Gold was so easily procured that it seduced all classes from their legitimate employments. You would see here a party of three or four lawyers, and perhaps a doctor amongst them; further on a skipper with his mate and boatswain. Further on would be a merchant and his confidential clerk, and likely one or two more of the same class in the party. Next a party of real old miners, laughing in their sleeves at their friends on each side. They had good grounds for merriment, for it usually took but a week or two to produce wheals and peel the hands of the amateurs at the pick and shovel. The work was not so easy as one would imagine. That, with rough living, and each having to take his turn at cooking—such cooking as it was—a damper, a Johnny cake, a pot of tea, and steaks or chops served up in a big tin dish—this sort of thing soon cleared al the diggings of amateurs at the pick and shovel. Infatuation, however, quickly subsided, leaving but the enterprising, hardy, and enduring to work out the golden destiny of the golden era of Australia.

One field after the other opened up in quick succession, and in about twelve months after Ophir, Bendigo, Ballarat, &c., in Victoria, the extraordinary yields from those fields brought enterprising men from all parts, but chiefly from California; and it is mainly to the credit of the practical energy and enterprise of those men that Victoria owes so much of its go-aheadism and vitality, which, springing from that spirit, took root and never died out.

During the first few weeks of our diggings, I, like many others, gained practical knowledge of the occupation. I hastened back to my own district—New England—judging from its geological formation that my toil and time in prospecting would not go unrewarded. Personally, it did; but the district and country benefited by opening large areas of auriferous country in what are now known as the northern goldfields, where even now, though thirty-seven years have passed, large areas of country I proved to abound in mineral wealth, where diamonds, rubies, and other precious stones exist, and where the clink of the pick and shovel have never yet been echoed from their solitary surroundings. I was the first to discover the northern goldfields, and open them up. I spent many months prospecting the country with my pick, shovel, and dish, and two horses, seldom two nights in one place, and over the vast area of at least 100 miles I found gold to exist everywhere.

Gold, tin, copper, and other metals exist more or less from one end of Australia to the other, and rich in many places not dreamt of. Quartz mining and the extraction of gold from other combinations is but in its infancy. Improved machinery for such purposes must be a source of much study and consideration to the English inventor and manufacturer to meet our requirements. The mineral wealth of New South Wales will for ages be its national bank, the source of investment of much capital, and the profitable employment of thousands. Those who open up the hidden wealth of the country render good to all.

Coal.

Coal is a source of great wealth and importance to New South Wales. It extends over vast areas of the country.

Professions.

The legal profession is favoured by aspirants to fame, practice being good, with liberal pay. Every village has its legal advisers. One solicitor in a town cannot get on very well. It takes two to quarrel. All other professions are well represented.

Sydney has produced some whose names will pass into history. The late Sir James Martin, Chief Justice, &c., and the Right Hon. William Bead Dalby, late Solicitor-General, one of the most genial, eloquent, learned, and well-meaning natives of Australia, who with a bold and patriotic stroke welded the first link of the chain that binds the destiny of England and her Colonies together, by being foremost in sending our volunteers to help the old country, and fight shoulder to shoulder with their brothers and the veterans of old England.

Occupations.

The great ambition of the Sydney native is to get into a bank or some Government billet. The result is that all departments are overcrowded; a good deal of this arises from the fact that there are few or no artistic sources of employment, and that every hon. member has a vote on divisions, and leading members in the interest of their constituencies must be conciliated.

The Australian girls, as a rule, are not given to industrial occupations, possibly from the fact that there are few inducements in factory work; or rather few factories where girls are employed, and possibly that families are too well off. They all dance to perfection; and all, to the shepherd's hut far away in the bush, play on the piano. Pianos are a great institution; there are more musical instruments amongst the people, per head, than in any community in all creation. The German and American iron backs are in great demand, and a great trade is done in them; the dry atmosphere of the country shrinks wooden pianos, hence iron is favoured.

Postal and Telegraphs.

In the early days postage was very expensive, and for many years in the outlying districts letters and papers only found their way through the kindness of wayfarers and friends travelling. Anyone going up country was anxiously sought after to be loaded with letters. I may be permitted to mention a case which will bear with some force on the efforts of Mr. Henniker-Heaton in pressing on the Government the urgent necessity of universal cheap postage and telegraphy. Up to about 1860 there was no postal communication on the north-west from Sydney, beyond a township called Mundooran. Although the whole of the country was, and had been occupied for years past for hundreds of miles beyond, yet, although we used every effort from year to year we could not induce the Postmaster-General to recommend the extension of the mail service until, by force of figures, collected from private sources, we proved that the correspondence would pay the extra cost. A fortnightly mail was then granted. (Previous to this we, a number of squatters, paid the Mundooran postmen, 100 miles from Cooramble, £10 each to bring

us our letters once a fortnight.) Correspondence multiplied, and ere long we had a bi-weekly service, and as our postal service became cheaper, so did it extend and pay.

The arguments in favour of Mr. Henniker-Heaton's efforts are stronger than they really appear on the surface. It is not only the benefit cheap services confer on the masses, thereby increasing and multiplying the correspondence, but revenues of the different countries would be doubly recouped, through the increased commerce thereby stimulated. If you only look deeply into the matter, and consider the wonderful increase of trade to be produced in all the various essentials for such extended postal and telegraphic facilities as is proposed by the hon. member for Canterbury.

For the sake of discussion, supposing an European war was to break out, what is there to prevent an enemy's cruiser in mid-ocean hooking up the cable, and cutting and towing one end of it away some hundreds of miles? Is not this possible? and would it in such a case be possible, if not probable, that our ships would not be able to pick it up again or repair it, or connect the communication, for a long time. I recollect a Russian scare in Sydney, before we had the submarine line, when the greatest excitement prevailed from the fact that we might see an enemy's fleet on our shores before we knew of declaration of war.

One fine morning in Sydney not long ago, when the people rose from their slumbers, they saw to their amazement the pennants of six foreign men-of-war brought up within pistol-shot of Government House. They were not seen by pilots or signal stations on the coast on entering the heads.

History repeats itself. It will be well for the old country and her colonies to at once join hands, and without procrastination set to work to provide another cable line, and not leave such gigantic interests on such fragile chances as exist at the present moment. I am not the only one that fully endorses Mr. Henniker-Heaton's efforts in this direction, but pledge ourselves to use every means to secure the speedy consummation of that which is so urgently needed.

Defences.

The defences of Australia have been so ably dealt with by Lord Brassey in his paper read before the Royal Colonial Institute, that anything I can say would be superfluous. I may, however, remark that our Governments have been fully alive to the necessity of efficient armaments for our defence, and, above all, for our coaling stations and coaling depots. Of the latter, the principal ones are Thursday Island and Albany. Both of those stations are the first touched at, on their respective routes, from all ports—Thursday Island—and Albany nine days from Colombo. The latter, Albany, as a harbour of refuge, for refitting, coaling, defence, and offence, is as essential as a base of operations on the southern Australian coast as those of Gibraltar and Malta.

While Albany is still under the special control of the Secretary of the Colonies, it being within the Colony of Western Australia, it behoves the Imperial Government to retain that ministerial power over it they now possess. Albany is of more importance to the Admiralty than casual observers see at first sight.

Summary.

Although in times past, when it was thought England would be well rid of Colonial incumbrances, the Colonial-office did not neglect our interests in the appointment of their representatives, yet, on the whole, the influences have been to assimilate our interests and social relations with the old country, and in this respect nothing could be more happy than the appointment of Lord Carrington, our present Governor, who, as well as Lady Carrington, have the happy tact of bringing all sections of a somewhat cliquish community like Sydney together; and the prerogative of the Crown is in the hands of a well trained and matured mind.

We are happy in the good offices of our Agent-General, Sir Saul Samuel, who spent the best part of his life in the service of his country as an industrious member of Parliament, and on several occasions as a Minister of the Crown. Thus from a long-continued Colonial practical knowledge he has rendered us the benefits derivable from such experiences, and through his genial and conciliatory disposition maintained and cemented friendly relations with our Colony and the Home Departments, as well as with all whom business or courtesy brought him in contact. If he does not come back, it is to be hoped the next appointment will be as fortunate.

There is one thing, however, certain, that a thorough reciprocity of commercial relations, on whatever lines they may be, tend above all things to federate the interests of communities, and certain it is that federation cannot result under differential tariffs.

Differential tariffs cause considerable friction

in the Colonies, and much annoyance in border revenue departments, but on the whole, the heart and interests of all are one with the parent country. The feeling of self-reliance in the defence of our constitutional rights, and of that of our hearths and homes, stands out on the picture like Mount Vesuvius from the Bay of Naples, "a beacon of fiery wrath to all invaders."

England need not fear Australia failing in the hour of need. The heart, pluck, and endurance of the old stock has not suffered degeneration under our climatic conditions.

Yet, while the Imperial government have the direct control of Western Australia, the Colonial-office should look well round before parting with that privilege. Western Australia is the only part of Australia left where a system of Imperial colonisation can be carried out under its direct control.

Now that emigration on large scales is contemplated, it is obvious that to meet such contingencies as have not before presented themselves, provision should be made by setting apart large suitable areas of suitable country for that purpose.

Once the Colonial-office parts with the whole of the territory into the hands of responsible governments, they lock the lands up in such a way as to bar immigration on any large comprehensive scale. And class legislation steps in to check it, with a view to discontinue competition with its labour market.

All the Colonies adopt this feeling from time to time, more or less. For instance, the Acting Agent-General for Tasmania has just received a dispatch from the Premier of the Colony, saying that in future no privileges whatever for selection of land will be given to emigrants, either to those paying their own passages or to those assisted by the Government, all Acts of Parliament under which such privileges were formerly granted having been repealed.

DISCUSSION.

The CHAIRMAN said that, at this late hour, there was not much time for discussion, but there were one or two points which he should like to touch upon. Mr. Buchanan seemed somewhat to depreciate the colony in some of his remarks, but he had omitted a very interesting series of statistics which rather combatted his opinion of the way in which the colony had been managed. He saw that the population of New South Wales in 1860 was 348,000, whilst in 1886 it was over 1,000,000, which did not look like going back. Again, the schools in 1860 numbered 798, with 34,000 scholars; in 1886 there were 2,833 schools, with 226,000 scholars, which again looked like a good advance. In 1860 there were 70 miles of railway, and earnings were £11,800; in 1886 there were 1,970 miles, and the earnings were £667,000. He must say, therefore, that some of the strictures passed upon the colonial management seemed hardly borne out by these statistics.

Sir OWEN ROBERTS said he should like to propose a vote of thanks to Mr. Buchanan for his very valuable paper. It was much more interesting to hear from a man—who evidently spoke from personal experience—such an account as had been given, than from others who were perhaps able to give as full an account, but whose knowledge was obtained through the medium of books and reports. With regard to what the Chairman had said in reference to the statistics, he was always amazed to think that such a great continent was still peopled so sparsely. It seemed absurd that a country represented by that large map only contained a population of 3,000,000, and when one thought of the immense possibilities open to it, and the double process at work—the natural increase of population and emigration from this and other countries—it seemed that the rate of increment must be much larger in the future than it had been in the past. He entirely agreed with Mr. Buchanan in his remarks with regard to Western Australia, and thought it would be nothing less than fatuous to give it up as a Crown colony. He could not but regret that so much of the great continent of Australia had been allowed to slip from our hands. As soon as a few people—some trumpery half-million or so—got together on a large continent, they created a sort of preference stock for themselves, and tried to keep out all the rest of the world from the benefits they had accidentally fallen into, but this was a selfish and absurd policy, and he could not but think the time was coming when the world would not allow such a monopoly to exist. At all events, with regard to Western Australia we had the remedy in our own hands, and he hoped the Government would see the matter in the light in which the author of the paper had put it. Mr. Buchanan was a large proprietor in New South Wales and also in Victoria, and it seemed very strange that two such adjacent colonies should have systems so diverse, one being free trade and the other protective. He hoped that great interest would be aroused with regard to our Australian possessions, not only amongst those who had an idea of emigrating there, but that the interests of the Colonies and the mother country would be more and more united, and that all would find means of obtaining more knowledge of the enormous capacities of that great country, Australia, and take care that their children had better means of

information than we ourselves possessed. He had known Mr. Buchanan since he came over in connection with the great Colonial Exhibition, and his Company (the Clothworkers) had had great pleasure in presenting him with their honorary freedom and livery, in appreciation of the great energy and success which had characterised his career. He thought it very fitting that a great Colonial citizen like Mr. Buchanan should also be made a citizen of London, the seat of the Empire, and he hoped there were many more amongst the colonists who had as large imperial hearts as Mr. Buchanan had shown himself to be possessed of.

The vote of thanks having been passed unanimously,

Mr. BUCHANAN, in reply, said he had not sought to give any opinion of his own, but simply to give the facts, and state the deductions which his own observations had forced upon him. As to the great progress which the Chairman had alluded to as being somewhat inconsistent with some of his remarks, he begged to say that he fully appreciated the great progress which Australia had made, but, at the same time, he thought it might have been greater. He did not wish to detract from the efforts of its administrators, but believed that with a different line of policy the progress would have been greater.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 18, 1888; W. H. M. CHRISTIE, M.A., F.R.S., F.R.A.S., Astronomer-Royal, in the chair.

The following candidates were proposed for election as members of the Society:—

Chatwood, Samuel R., 11, Cross-street, Manchester.
Ince, Surgeon-Major John, M.D., The Mount-house, Farningham, Kent.
Threadgele, Charles, M.B., The Provincial Hotel, Dublin.
Tomkinson, Michael (Mayor of Kidderminster), Franche-hall, near Kidderminster.

The following candidates were balloted for and duly elected members of the Society:—

Bonner, Horace Thomas, 29 and 30, King-street, Cheapside, E.C.
Cox, John Buchanan, 27, Apach-road, Brixton-rise, S.W.

The paper read was—

TELESCOPES FOR STELLAR PHOTOGRAPHY.

By SIR HOWARD GRUBB, F.R.S.

I will ask you to remember that the subject of this paper is not that of the proposed International Photographic Survey of the Heavens itself, but of the instruments which are to be used for that survey. No doubt a communication on the survey itself, dealing with the results aimed at, the conditions under which it is considered the best results may be arrived at, and the general scheme under which it is proposed to measure, define, and catalogue the position of the stars obtained, would be more generally interesting than one on the mere instrumental equipment; but this part of the subject has already been amply and most efficiently dealt with in lectures by Mr. Common and Dr. Gill at the Royal Institution, while the subject of the instruments to be used has only as yet been discussed in the more scientific and technical journals or proceedings of Societies; besides which, I may be pardoned for saying that I think when actual work is commenced, the perfection of the instrumental equipment will be found to be a larger factor in the attainment of success than has ever been the case in any previous astronomical research. There is probably nothing which surprises and excites the admiration of the modern astronomer more than the work done in bygone times by some of the older astronomers; work which was the outcome of marvellous patience and ingenuity while working with tools which would excite the pity and contempt of the merest tyro in astronomy of the present day; but while I am by no means a sceptic as to the most important part of all telescopes being "the man at the small end," I do believe that never before in any system of astronomical observing has "the man at the small end" been so completely dependent on the excellence of his instrumental equipment, a disarrangement of any one part of which would leave him utterly helpless. I trust, therefore, you will bear with me while discussing and describing a few of the more important mechanical details of these instruments.

You are aware, probably, that an international congress of astronomers was held last year, in Paris, and that it was decided to start a number of observatories, in various parts of the world, each to take its share in producing photographs of the heavens, to be afterwards used in compiling a general chart, in which stars down to the 14th magnitude would be entered.

Before we go further, it may be well to explain the difference between this system of charting and the old system, and what circumstances have led to this proposed revolution in astronomical work.

The system of mapping stars which has

been used up to the present time consists, as you are aware, in observing all the stars *seriatim*, in a transit circle, or similar instrument, and tabulating their declination (*i.e.*, angular distance north and south of the Equator), or Polar distance, as found by readings of the vertical circle, and their Right Ascension (*i.e.*, their distance measured on the Equator from an empirically fixed point in the heavens), as found by the difference of time of the sidereal clock, between the passage of the star across the centre wire of the telescope and that of the fixed point above referred to. The essential point in the above system which I have to direct your attention to is, that every single star has to be examined *by itself*.

The magnitude of the work of such a survey as the Paris Congress has decided upon may be inferred from the fact that there are probably some 20,000,000 stars to be examined and catalogued. It is a good year's work of a transit circle to tabulate 5,000 stars; supposing, therefore, 30 or 40 observatories divide the work between them, the survey would still occupy over 100 years, and by that time the proper motion of the stars would render a new survey necessary.

Now, ever since photography has been practised, it has been the dream of the astronomer to photograph the heavens, and obtain, at one and the same time, the positions not of one but of hundreds or, perhaps, thousands of stars in each operation. But, then, it may be asked, why was not photography employed long since? The answer is, that until recently the amount of sensitiveness obtained was not sufficient to allow of the fainter stars impressing the plate within reasonable time, and consequently, it was found impossible to produce satisfactory stellar photographs, except of the larger stars.

Dr. Warren de la Rue was the first to point out the use which might be made of photography for the purpose of star-charting, and, as far back as 1860 and 1861, produced photographs of star clusters, &c.

In 1864 or 1865, Rutherford, of New York, obtained photographs of the larger stars, and while photographing the moon with the great Melbourne telescope in 1867 I took, for the purpose of adjustment, some photographs of "Castor;" but in an article which I wrote for the "British Journal Photographic Almanack" in 1869, I pointed out that for the development of celestial photographs we would have to look to the chemist and not to the optician, in other words, that until we obtained more suitable plates, we could not expect much advance. This has proved to be the fact, for with the advent of the gelatine plates, and consequent increase of sensitiveness, celestial photography received that impetus which has eventuated in this proposition of an International Photographic Survey. I also pointed out in that same article nineteen years ago that, if by any possibility the exposures could be reduced so far as to render the unsteadiness of the image insensible—a rapidity which I said there was no reason to suppose might not be obtained in the case of the sun—we might expect great results, a prediction which has since been verified by Professor Jansen's magnificent pictures of the sun with which you are all familiar.

It is almost superfluous to remind you also of the magnificent picture of the nebula in Orion by Mr. Common, an example of celestial photography never yet surpassed,

In 1882, Dr. Gill sent home to the Royal Astronomical Society, and to the Paris Academy of Science, a photograph of the great comet of that year, and called attention to the large number of stars photographed on the same plate. This photograph was obtained with an ordinary photographic lens and camera attached to a clock-driven equatorial.

It was this, perhaps, that influenced the Paris Observatory to construct the photographic telescope of about 13 inches aperture, 11 feet focal length, specially corrected for the chemical rays, with which the splendid star charts of the Messrs. Henry were obtained. Meanwhile others were not idle, and while Dr. Gill, through the munificence of Mr. Nasmyth, obtained a 9-inch achromatic, which I corrected of course for the chemical rays, Mr. Roberts, of Liverpool, had a 20-inch reflecting telescope constructed for the same purpose.

It soon became evident that this new departure in the system of star-charting was likely to be of very great importance, and consequently an International Congress of Astronomers assembled last year in Paris to discuss the whole question. This Congress defined the size and focus of the object glasses to be used, and laid down a certain standard for the correction of the chromatic aberration suitable to the nature of the work; but left almost all other points free for individual astronomers to deal with as they thought best. In fact, the Congress wisely defined only just such points as were necessary

for securing uniformity in the scale of the photograph, all of which it is proposed shall be sent to some central bureau to be examined, discussed, and made use of in compiling the chart.

But it may be asked where is the great difference between this system and the old, as the positions of the star images on these photographs have to be measured *seriatim*, just as the stars themselves have to be measured *seriatim* in the old system. This is no doubt true, but under what different conditions are the measurements made.

None but those who have worked in this field know the labour represented by a volume of 5,000 star places under the old system.

How many times does that wretched bit of cloud come across the field just as the star reaches the centre wire of the micrometer, and how many nights, beautiful and clear as they may look to ordinary individuals, prove utterly worthless for all observing purposes; but under the new system, once a single good plate has been obtained, there is a permanent record of some hundreds, or in some cases thousands, of stars, which can be measured at leisure by day or by night, in good weather or bad weather, and in comfort in your office or study, and there also is that photograph as a permanent record which can be referred to at any time as a check on errors which might possibly creep in to some of the final reductions.

In fact this new system gives us the means of taking advantage of the very few really favourable opportunities of observing, and of producing, during those favourable moments, a *fac simile*, so to speak, of any portion of the heavens which we can examine and survey at our leisure without any of the difficulties or discomforts attendant upon direct astronomical observations, and under conditions far more favourable to the obtaining of accuracy in the results.

Let us now consider what are the chief points to be attended to in the construction of the instrument. It is evident that what is required is an instrument which

1. Can be accurately pointed at any given object.

2. That when pointed in the desired direction the clockwork shall cause it to follow that object as steadily as possible.

3. That as the meridian is the best position for observation, the instrument should be capable of working for some distance on each side of the meridian without reversing.

4. That means should be supplied by which the observer can watch and verify the accuracy of the clock driving or making any change in position rendered necessary by refraction.

The first point involves delicate and accurate slow motions in Right Ascension and Declination.

The second involves great steadiness and rigidity of the mounting, great smoothness of motion of the polar axis in its bearings, and above all most accurate clock-driving motion.

The third point involves either the adoption of the old English form of mounting, or a modification on the German form, as the latter does not generally allow of motion for any considerable extent beyond the meridian without reversal.

The fourth merely involves a very powerful finder—or, rather, guiding—telescope with suitable micrometric eye-piece arrangements.

Respecting the relative merits of refractors and reflectors for this purpose, I shall speak just now; for the present I wish to direct your attention to the instrumental part only, and, for the better understanding the peculiarities of the various mountings, I will now throw photographs of some of them on the screen. The first illustration is that of the Paris equatorial, with which the well-known and deservedly praised star pictures of the Messrs. Henry were produced.

You see it is of the construction generally known as the "English" equatorial. A long split polar axis, with bearings for carrying the telescope at the centre (its weakest point). This form of equatorial has many advantages, which at first seem to render it peculiarly fit for this special work. With good slow motion, and a large finder telescope, it admirably fulfils the first, third, and fourth of the above conditions; but, owing to its peculiar form, and the difficulty of using a driving sector of long radius, it is not well calculated to fulfil the second and most important of all conditions, viz., the accurate following. No doubt excellent work has been done with it by what is called the "eye and hand" guiding. That is, the star is watched in a powerful finder, and when it is seen to err sensibly in position, it is brought right again by the slow motion handle. I think it is generally allowed that the undoubted excellence of the work done by the Messrs. Henry is due more to extraordinary patience and skill in the "eye and hand" guiding than to any unusual perfection of the clock driving. This form of instrument also possesses a disadvantage in being very difficult to arrange for work near

the pole. The second illustration is of Dr. Gill's 9 in. photo telescope, with which he took his star pictures. There is nothing peculiar about the mounting of this, being in fact an old equatorial which I sent him some years since.

In this case also the excellence of his results is to be attributed to the skill of the observer, and not to any inherent excellence of the clockwork; but that excellent work has been done with it is apparent from the perfection of some of his photographs. The next illustration is that of the telescope of Mr. Isaac Roberts, of Liverpool, for whom I mounted a 20 inch reflector to experiment with. As you see, it is mounted on what I call the twin form, as I mounted Dr. Huggins's instrument, by the adoption of which the observer always has a second telescope available for visual work, if anything interesting should appear in the heavens.

With this instrument Mr. Roberts, working in the exceptionally wretched atmosphere of Liverpool, has secured some most admirable work, a few specimens of which I now throw on the screen.

This is the first instrument, as far as I know, in which a successful attempt has been made to drive, for any considerable time, without "eye and hand guiding." The special system of clockwork used I will describe further on.

So far as the general form of the instrument is concerned, it would appear that the balance of advantage lies with the German form (so called), that usually adopted in this country. It is capable of being made of great stability, and it admirably fulfils all the conditions except the third, but that also, by a little modification, can be managed. The next illustration shows the general form which I have adopted, the principal feature of which is great stability. The stand being cast all in one piece contributes to this, but the peculiarity of the system of equipoise probably has more to do with it.

In designing these instruments, I proposed that the fulcrum of the levers which support the greater part of the weight of the polar axis, should be attached, not to the frame of the instrument, but to an independent pillar, so that only a very small portion of the weight of the moving parts should be carried by the main framing. Dr. Gill then proposed that I should also allow the levers to act in a purely vertical direction, instead of, as usual, in a direction at right angles to the polar axis, and to let the point of support be vertically under the centre of gravity of the whole moving part. This I have carried out, and the result is that only as much of the weight of the whole instrument as is necessary to ensure steadiness will rest on the bearings (lateral or end bearings) of the polar axis; all the rest is transferred to the base of the stand.

We now come to consider the all-important part of the photographic equatorial, that is the driving clock.

All clocks used for driving equatorials (which must of course move uniformly, and not step by step as pendulum clocks), may be divided into two classes—*(a)* those in which uniform motion is obtained, or sought to be obtained, by some variable friction or resistance which increases as the speed increases; and *(b)* those in which some such similar contrivance is supplemented by a system of electric control from a pendulum clock, which is itself incapable of being re-acted upon by the uniform motion clock.

For all ordinary observing, and even for micrometric work, clocks of the class *a* are made, which answers admirably, but for photographic equatorials I believe it will be found necessary to employ clocks of the *b* type, and for this reason:—The tendency of the compensation in uncontrolled clocks (class *a*) is to correct the *rate* of the clock when from any momentary cause it is disturbed. The best it can do is to bring the *rate* absolutely right again, but it cannot act till an error has actually occurred, and therefore, although the rate is corrected, the *position* of the star on the plate is shifted by the amount of the error. I have heard it stated by the designers of some of these clocks that errors were corrected *before* they existed! It is hardly necessary to stop to show the fallacy of this, but it is evident that the increased or diminished resistance, or friction, or whatever it is, that checks the speed, can only exist from, and in consequence of, the error itself.

In the case of micrometric measures, it is not of very much consequence if a minute error occasionally creeps in, provided the speed keeps constant during the few seconds or minutes required for making the bisections, but in the case of the photographic telescopes, if the image of the star takes up a new position any time during the exposure, it is of course fatal.

Let us try now and get an idea of what amount of accuracy is really necessary for this work. We often hear of a perfect equatorial clock, but the word perfect is, I fear, as loosely used in this connection as in others.

I have heard in days gone by a perfect clock defined as one which drove the instrument so accurately that if you set the telescope on a star and went to dinner you would find the star still in the field when you resumed your observations after dinner. Allowing, say two hours, between the anti-prandial and the post-prandial observations, and assuming the eye-piece to be (as we may fairly do) a low one of about 20 minutes of arc field; this would mean that the clock did not vary more than 600″ of arc or 40 seconds of time an hour. The accuracy we now require for these photographic telescopes is something very different. The image of a 12th magnitude star impresses itself on the plate, with moderate exposure, in the form of a circular disc of about $\frac{1}{100}$ inch diameter. If the clock vary one-tenth of a second during the exposure, the disc will be elongated by $\frac{1}{1000}$ inch, producing a very sensible distortion.

We must not therefore have any errors over one-tenth of a second, and if possible it should be reduced to one-twentieth.

It will not be necessary that the clock keep within this one-twentieth of a second for more than ten or fifteen minutes, because it is always necessary to watch the image occasionally through the guiding telescope, and correct whenever refraction becomes apparent; but what I do urge as absolutely necessary is that the clock shall go so perfectly as not to require more than the occasional attention of the observer, instead of the constant and never ceasing watching with ordinary clockwork. No one who has not tried it can imagine the strain required to keep a constant watch on a star image for 30 or 40 minutes, but if attention be only required for a second or so every few minutes there is no difficulty or irksomeness whatever.

Even the most enthusiastic admirers of various forms of equatorial clocks will not venture to assert that they will go for 15 minutes without one-tenth of a second of error. There is now, however, no difficulty in controlling an uniform motion clock from a pendulum so that it will never vary one-twentieth of a second from it. It may, therefore, I think, be assumed that some form of electrical control is necessary. There are, as far as I know, four forms of control to choose from.

First, Dr. Gill's, as applied to the 15″ equatorial at Dun Echt with admirable success. In this an electric current is sent once a second from an independent pendulum, which may be any distance away. That current passes through a certain wheel in the clock, with contacts so arranged that if the clock be going exactly with the pendulum the current is sent a direction which keeps one of two rubbers rubbing on a quick moving wheel of the clock. If the clock, however, goes the least quantity too fast, the wheel has revolved a little further than it should at the moment the next current comes from the pendulum, and the current is sent in such a direction as to cause both rubbers to rub on the clock wheel. If, on the contrary, the clock has gone a shade slower, the current is sent in a third direction, which lifts both rubbers off. This control, so far as it goes, acts almost perfectly, but it is open to this objection, that as it only corrects the errors of whatever shaft in the clock the contact wheel is attached to, any error in wheels between that and the telescope screw are unaffected by it; also I find in practice that when it is attempted to control a clock by alteration of friction, on any heavy quick moving part, it takes some little time to act, and then generally overdoes the correction, causing what is generally termed "hunting." The second form of control is the first which I introduced.

Fig. 1 is an elevation, and Fig. 2 a plan of the arrangement which is attached to the back of the main clockwork, and can be seen in Fig. 3 at E, but on too small a scale for description; A is a portion of one of the uniform clock motion spindles, or any shaft coupled thereto; B, B, B, are the three wheels of an ordinary mitre *remontoire* train driving by weights, W, the scape wheel, C, into the teeth of which gears the pallets, D D, which pallets are driven by the electric pendulum P.

The electric pendulum is connected to and driven by a current from any independent clock. To the weight-carrying arm of the *remontoire* is attached a small chain or wire, which communicates any motion it may have to the lever, L, from the other end of which lever hangs a weight, *w*, smaller than W, which weight is therefore raised when the *remontoire* arm is lowered, and lowered when the *remontoire* arm is raised; Q is a disc of metal on a vertical spindle of a uniform motion clock, and revolving rapidly (say 300 per minute). When the weight, W, is below its mean position, it is contact with the disc Q, and (the lower end of it being coated with leather) produces a considerable amount of friction, and therefore tends to retard speed of clock; when the weight, W, is above its mean position, it is altogether out of contact with the

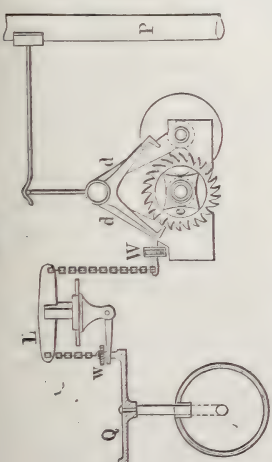


Fig. 1.

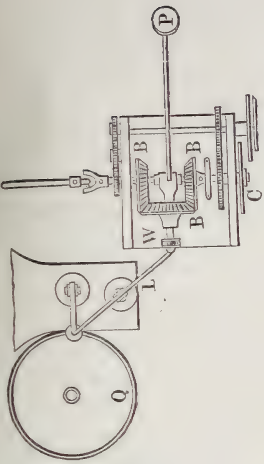


Fig. 2.

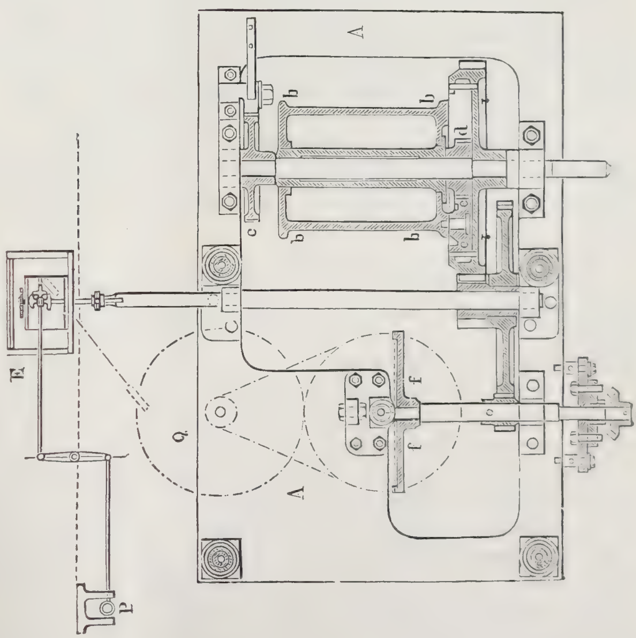


Fig. 3.

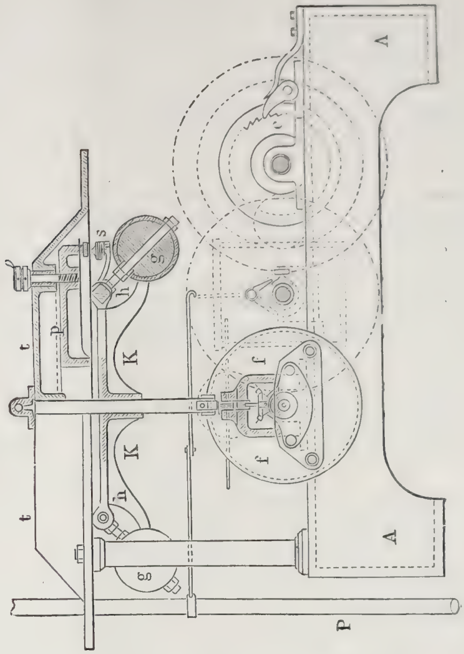


Fig. 4.

disc Q. The action is as follows :—Supposing the shaft, A, to be revolving exactly one per minute, the pendulum to be vibrating exactly 60 per minute, and that there are 30 teeth in the scape-wheel, it is evident that the *remontoire* arm, and therefore, the weights, W, and *w*, will vibrate backwards and forwards the same distance each second, and that the mean position of all will be the same each second. Under these circumstances, the weight, W, will be alternately 0·5 second in contact with disc Q, and 0·5 second out of contact, and the uniform motion clock is rated, *per se*, just so much fast, that the resting of the weight, W, for 0·5 second in each second, will bring the rate right.

Now, suppose an error of acceleration to arise in uniform motion clock, the mean position of *remontoire* arm will rise; therefore, W will fall, and, instead of rubbing in contact with Q for 0·5 second, it will rub for 0·6 or 0·7 second, according to the extent of the error. This will tend to check the rate, and this check will continue till the relative position of the uniform motion shaft becomes as it was when the clock was going correctly.

If a retardation occurs, the reverse effect will take place, and the weight, W, will rub only for 0·4 or 0·3 second, instead of 0·5, until the error be corrected.

So far as described, there was no particular novelty, as most of this arrangement, in principle, had been tried before, the failure that had resulted being due to the fact that it was found impossible to prevent the pendulum being influenced by the difference of force on the pallets, under varying circumstances, the pendulum being in the former case driven by the scapement; not by electricity, as in this case.

This difficulty was got rid of by :—

1. Making the pallets (as they are not required to drive the pendulum) of such form that the teeth of scape wheel impinge upon them nearly at the angle of repose.

2. By driving the pendulum by electric current from another clock, thus virtually rendering the pendulum not a pendulum at all, but a lever worked backward and forward by electricity, and not subject to alteration in its rate by slightly varying force on the pallets.

An arrangement is also attached (but not shown in the Fig. to avoid confusion) by which if either portion of the clock fail to do its duty from want of winding, want of electric current, or other cause; the connection between the two systems is instantly severed, automatically.

In considering the essentials of a good system of control for equatorial clocks, it is necessary to keep in view the exact conditions required. It is not sufficient that the controlling apparatus (of whatever form it may be) should simply bring the *rate* of the clock, which has been interfered with by some adventitious disturbance, correct once more; it must do more, it must correct this error. For, suppose a star be set on the slit of a spectroscope, and the clock started, and say, as in Dr. Huggins's case, a photographic plate inserted for a two hours' exposure. Now suppose that five minutes after the commencement of the exposure, a error of one-tenth or two-tenths of a second occurs from some disturbing cause (a fragment of dirt on the tooth of a wheel, or other cause); if the controlling apparatus be of such a nature as simply to bring the clock-rate correct again, the position of the telescope will be the above quantity, one-tenth or two-tenths of a second, in error for the remainder of the exposure, although the rate may be absolutely correct for the whole times. In other words, the star will have moved off the slit, by a quantity equivalent to what the instrument would move in one-tenth or two-tenths of a second, and will continue off the slit for the remainder of the two hours. So it will be seen that no controlling apparatus is of any use whatever, unless, as well as keeping the rate uniform, it corrects the errors that have crept in. In consequence of not keeping this point in view, many most ingenious but useless arrangements have been from time to time proposed. A little consideration will show that this arrangement meets all requirements.

The above arrangement is somewhat similar to Dr. Gill's. It is simpler to attach to any existing clock, but not so delicate as his, and is open to the same objections. It is, however, capable of very good work, as may be judged from the chronograph sheet of the Dunsink Observatory chronograph.

The third is the form of control which I devised for Mr. Isaac Roberts, and which has been so successful with him, and with Professor Pritchard (who has had it recently attached to the Oxford equatorial), that photographs have been exposed with the telescope to which it has been attached for 15 minutes, and yielded perfect images of stars without any hand and eye guiding.

The arrangement consists firstly, of a *remontoire* train, driving a good mercurial or other compensated pendulum—the driving of this

train being of course entirely independent of the equatorial clock giving motion to the telescope; secondly, of a detector apparatus, which detects any difference between the rate of this standard pendulum and the equatorial clock; and thirdly, of a correcting apparatus, which corrects automatically any error discovered by the detector. This corrector itself consists of two parts—an "accelerator" and a "retarder"—and these we will first proceed to describe.

In S S′ S″ is one of the shafts, between the driving train of the equatorial clock and the worm which drives the right ascension sector, this shaft being cut into three parts denoted by the letters just named. At one end the portion S of the shaft carries a wheel, 1, immediately adjoining which is the wheel 2, mounted on the portion S′ of the shaft. At the other end of this last-named section of the shaft is fixed a third wheel, 3, which is almost in contact with the wheel 4, fixed on the end of the shaft S″. The shafts S and S′ also have mounted freely on them the brass discs, *d d′*, which adjoin the two pair of wheels referred to above. Each of these brass discs is furnished with a stud on which a small pinion is mounted, the pinion *p*, belonging to the disc *d*, gearing across the pair of wheels, 1-2; while the pinion *p*, belonging to disc *d′*, gears across the pair of wheels, 3-4.

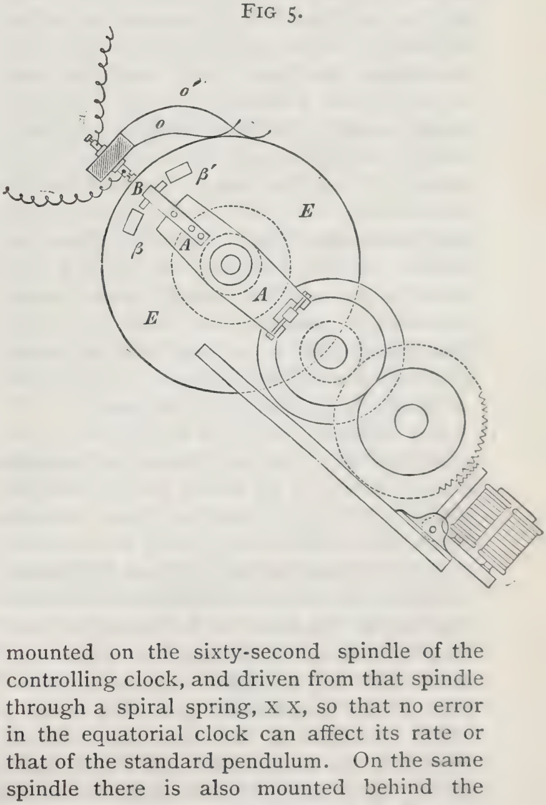
Under normal conditions, if no error exists in the equatorial clock rate, the arrangement of wheels and pinions just described revolves as one piece, the three sections, S S′ S″, of the shaft rotating at the same speed, but it is possible, by an arrangement which we shall explain presently, to stop the rotation of either of the discs, *d d′*, and as soon as this occurs the pinion of the stopped disc has to act as a transmitter of motion from one of the wheels into which it gears to the other. If the two wheels of each pair had the same number of teeth the speed of both wheels would still remain the same, but in reality the number of teeth in the two wheels of each pair is different, and hence the stopping of one of the discs, *d* or *d′*, causes a variation in the rate of rotation of the two adjoining wheels relatively to each other. For instance, in the case of the first pair of wheels, let wheel 1 have 30 and wheel 2 have 29 teeth, and suppose that the shaft S is rotating once every 60 seconds. Thus, if the disc *d* be stopped, the wheel 2 will be made to revolve in $\frac{29}{30}$ of the time occupied by the wheel 1, or in other words the rate of the section S′ of the shaft will be accelerated to one revolution in 58 seconds. In the same way by reversing the positions of the wheels in the other pair 3-4, the stoppage of the disc *d′* can be made to effect a retardation of the portion S″ of the shaft relatively to S′. The edges of the discs *d* and *d′* are cut into very fine teeth, and the stoppage of the discs when desired is effected by causing a comb attached to the armature of an electro-magnet to engage with these teeth.

The whole apparatus just described constitutes a very convenient arrangement for accelerating or retarding the driving motion imparted to the telescope by the equatorial clock, and that it is capable of very good work is shown by the photographs which have been taken by Professor Pritchard and Mr. Roberts, in which the star discs are perfectly round, though exposed for 15 to 60 minutes, and no hand guiding used.

I have now to describe how this apparatus is, when necessary, automatically brought into action by the "detector."

In Figs. 5, 6 and 7* W is a scape wheel

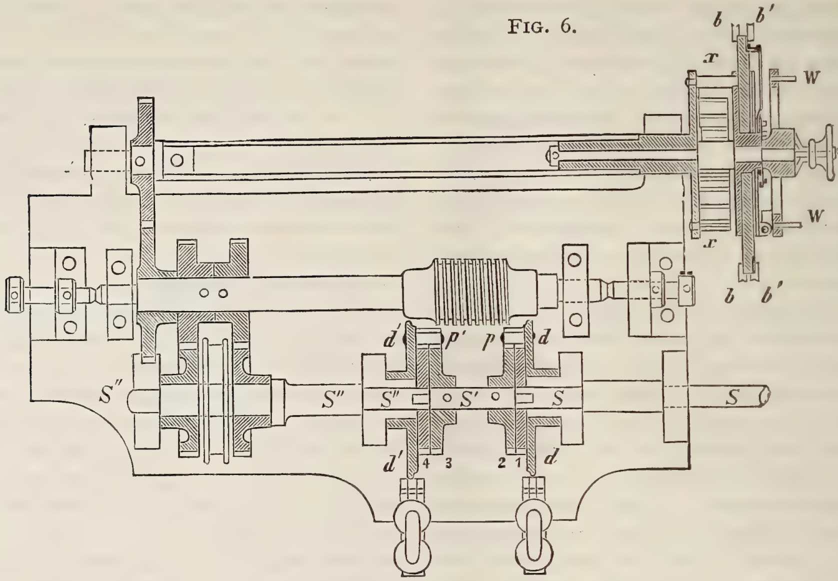
FIG 5.



mounted on the sixty-second spindle of the controlling clock, and driven from that spindle through a spiral spring, X X, so that no error in the equatorial clock can affect its rate or that of the standard pendulum. On the same spindle there is also mounted behind the scape-wheel an ebonite disc, E E, Fig. 5;

*These blocks have been kindly lent by the Editor of *Engineering*.

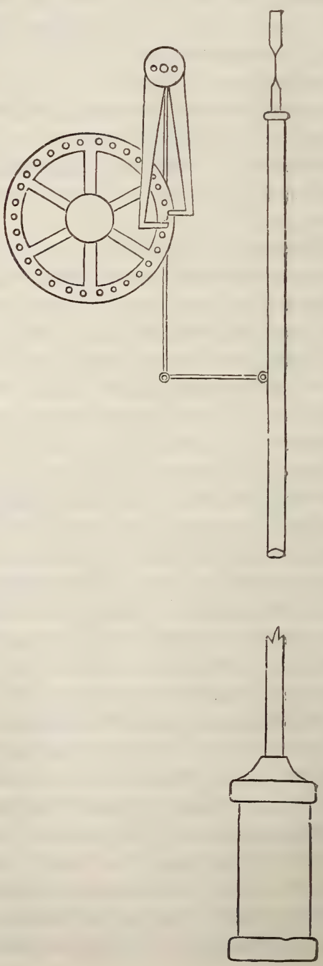
FIG. 6.



this disc, which is driven by the equatorial clock, carrying two insulated rings, *b b′* which are respectively connected metallically with two platinum plates, B B′, inserted in the face of the disc. Between the scape-wheel and the ebonite disc there is also mounted loose on the spindle a lever, A A, which carries at one of its ends a platinum bridge, B, which is of such a length as to fit between the platinum plates, B B, and which in its mid-position bears against a piece of rock crystal let into the ebonite disc between the two plates just named. At the other end the lever, A A, is formed into a fork, between the arms of which projects a pin carried by the scape-wheel; the arms of the fork are provided with set screws, by means of which the amount of play allowed to this pin in the fork can be adjusted.

The insulating rings, *b b′*, are electrically connected with the accelerator and retarder already described by means of fine platinum wires, O O′, wiping against them, and the action of the whole arrangement is as follows. The scape-wheel, W, being driven by the control clock, has an intermittent movement corresponding to the beats of the pendulum, while the ebonite disc, E E, being driven by the equatorial clock, has a constant movement, so that even if the scape-wheel and disc make a whole revolution in the same time, the pin carried by the scape-wheel will be constantly oscillating between the pins of the fork at one end of the lever, A, this lever being driven by friction from the ebonite disc. The pins just named are adjusted so as to allow of this

FIG. 7.



oscillation taking place without interference, so long as the rates of the equatorial and control clocks remain uniform, but if the equatorial clock either loses or gains with respect to the standard, the pin on the scape-wheel comes into contact with one of the fork pins of the lever, A, and shifts that lever on the spindle, bringing the bridge, B, into contact with one of the platinum plates, B or B′, and transmitting a current which brings into action the accelerator or retarder as may be required. The period during which the accelerator or retarder remains in action will depend upon the amount of the error to be corrected, and the proportions of the pairs of wheels, 1 2, and 3 4. With the proportions described above, the correction introduced is one-thirtieth of the rate, so that to correct an error of one-fifth of a second, the accelerator or retarder, as the case may be, would have to remain in operation $\frac{30}{5} = 6$ seconds. As soon as the correction has been made, the lever, A, will resume its normal position, and the bridge, B, coming then between the two platinum plates, B B′, a current will cease to be transmitted, and the accelerator or retarder thrown out of action.

It is to be noted that the apparatus above described not only corrects any temporary disturbance of the equatorial clock rate, but cancels errors which have already occurred.

It will be seen that the third form of control is free from the objections of first and second. The detector part of the apparatus is close to the screw spindle, only removed from it by one pair of wheels, and the correction is not applied in the same manner by checking the speed of the clock, but by introducing a differential gear, which acts until the error be cured, and then drops out of gear automatically.

The fourth and last form of control, however, is that to which I would invite your special attention, for I believe it to be capable of results beyond all the others.

I have endeavoured in it to select all the good points of the other forms, and to combat the weak points. I may not have as yet produced it in as perfect a form as is possible, but I am satisfied it is capable of development into a very perfect control, and even at present it is the most perfect I have constructed.

As long as the control applied its correction by altering speed of governor, it was necessary to keep down the *vis inertia* of the governors, but now, as the correction is not applied in this way, I have made the governor very heavy, and running at a very high speed.

The *vis inertia* of the governor is represented by some 10,000 foot-pounds per minute, consequently it is little affected by any small or short differences in friction or driving powers.

Again, at the suggestion of Dr. Gill, I make the governor spindle gear directly into the counter spindle of the screw, in order to have as few wheels and pinions to deal with as possible. Errors of wheels behind the governors have nothing whatever to do with the accuracy of its rate.

As to the nature of the control, I use Dr. Gill's form of detector and my own form of corrector, viz., accelerator and retarder. I use Dr. Gill's detector because it seems to be capable of being made on a larger scale than mine, and consequently ought to be more delicate.

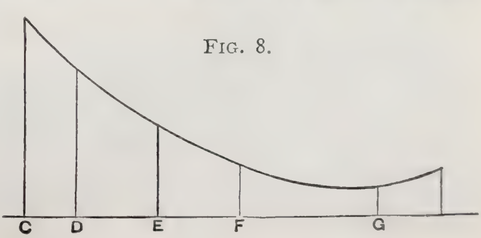
I now propose to say a very few words on the optical part of the instrument.

The first question that naturally occurs, is whether a refractor or reflector should be used. I own that when I first considered the subject, I inclined to the belief that reflectors would be found to be the most suitable; and in a paper of mine, which was read before the Royal Astronomical Society last spring, I urged that comparative trials should be made before a final decision was arrived at. I have found reason, however, to modify my views on this point.

My reason for thinking that the reflector might possibly prove the best, was founded on the consideration that in reflecting instruments rays of all refrangibilities are brought to a focus at one and the same point; whereas in the refractor, rays of various refrangibility have different foci, and the best we can do is to so arrange the curves that those rays most active in impressing the photographic plate may be brought as nearly as possible to the one focus.

If we draw a curve which represents the position of the focal point for various rays of the spectrum in an object glass corrected for photo work, it will be something like this figure (8). The same for a reflector will be

FIG. 8.



represented by a straight line. Looking at these curves, it is certainly a natural conclusion that the reflector ought to be best, and therefore it was that I urged that a fair comparative trial should be made between the reflector and refractor as to their suitability for this work.

The congress, however, decided upon the use of refractors, from the simple fact (as Dr. Gill says) that the best work done (to that time) had been done by refractors, not taking into consideration the very much more favourable conditions under which the refractor photographs were taken. Since that time further experiments have been made, with both forms of instruments, which tend to show that, as against the refractor of the ordinary construction, the reflector can well hold its own, but that while it is obviously impossible for the optician to improve the field of the reflector, it is by no means impossible to do so with the refractor, and time and patient experimenting have shown that, by a modification of the curves of an objective, equally good definition of the central pencil can be obtained, combined with a very much better and flatter field, so that however well reflectors could compete with the ordinary form of refractor, they cannot do so with forms constructed with special reference to field.

It should be borne in mind that the question of field is one which the optician was never before asked to consider in telescope objectives. The field of such a sized telescope used for visual work would not be more than $\frac{1}{2}°$, even with the lowest power. It has been found possible to obtain good definition over a field of 2° with either reflector or the ordinary form of refractor, and with the modified form considerably more. This question of field is, as I said, a very important one, for on it depends the amount of time required to complete the survey. If one instrument gives equally good definitions over 3° square, *i.e.*, nine square degrees, as another does over 2° square, *i.e.*, four square degrees, it is evident that the first instrument, equally energetically worked, is capable of completing the survey in less than half the number of years, it is possible to do with the second instrument.

There is one point connected with this question of field which is of great importance.

Various forms of objectives give various characters of images of star discs at the edge of the field. Some give a bright nucleus with a tail like a comet, some assume a form approaching to a cross, and some give elliptical discs.

Of course perfection would mean absolutely circular discs all over the plate, but when this cannot be obtained, the last or elliptical discs are very much preferable to either of the others. It is quite possible to fairly estimate the most central point in an ellipse if the illumination over it be tolerably equal, but in the case of the comet or irregular form this is not possible.

The newer forms of objectives are peculiar in that the distortion of the lateral star images are of their least objectionable character.

It has been suggested that good results might be obtained by using the new "Jena" glass with rational spectra, but I have made inquiries respecting this, and it is not considered by the makers themselves that this glass in its present state would be suitable for the purpose of these photographic objectives. Until the permanency of that glass be thoroughly tested by exposure to various climates for some years, it does not appear safe to use it for such important work as this. There can be little doubt, however, that for ordinary visual work this glass, if capable of being made into large discs, will allow of the production of objectives superior to anything hitherto made.

I ought perhaps to mention that it is possible to make an objective which can be adjusted to work either as a photographic or visual objective.

By separating the lenses of an ordinary objective, the chromatic correction can be so much reduced as to render it suitable for photographic work, but unfortunately the spherical aberration is reduced at the same time and definition destroyed.

Professor Stokes, however, suggested to me that by constructing an objective in such a manner that the crown lens would be unequally convex by a certain amount, and that the spherical aberration would be correct when the flatter side was outermost, that then the chromatic aberration could be reduced as before by separating the lenses, and the reduced correction for spherical aberration raised by turning the crown lens with its more convex side outwards.

This I tried, and found act perfectly.

I described this last spring at the Royal Astronomical Society, but it has since been re-invented in America.

It remains for me now only to describe how these new photographic objectives are tested.

The testing of objectives for visual work is a matter almost altogether of eye experience.

In these photographic objectives, a different course must be adopted, as the image appears to be badly corrected to the eye when it is rightly corrected for photographic rays.

The Paris Congress decided that the rays G of the spectrum should have in their objectives a minimum focus; how is the correction to be verified? It is usual in the testing of the chromatic aberration of objectives, by those whose eye experiences cannot be a sufficiently accurate guide, to allow the image of a star, as found by the objective, to fall on the slit of a spectroscope, and to judge of the focus of each particular ray by the breadth of the spectrum at that ray. Wherever the light is brought to a focus, the spectrum is of insensible breadth. When it is out of focus, a more or less sensible breadth, by moving the spectroscope in and out the position of maximum and minimum foci, can be obtained.

I tried this plan, but found it very unsatisfactory, as it was very difficult to determine the exact place where the spectrum was narrowest, the curves being so very shallow.

After much thought, I arrived at the following very simple and efficient plan, which I describe in full, as it may be useful to some for other purposes. It should be remembered that the object is to get the focus of the objective for various parts of the spectrum.

If, therefore, we could obtain various objects when light was derived for such portions and such portions only of the spectrum as we required, our object would be accomplished.

I take a spectroscope with a fairly large dispersion equal to about 2 prisms of 60° and with a pencil of light of about 2° diameter. I remove the observing telescope, and substitute one of very long focus so that the linear dimensions of the spectrum shall be as large as possible. I observe with this the solar spectrum, and note the position of such lines as I intend to work on. I then remove the eye piece and insert in its place a tube carrying a small convex mirror. The apparatus is left till dark, and a small electric glass lamp attached outside the slit. The observing telescope is then placed at such a reading as I know will bring any certain lines into centre of field, and on looking at the small mirror through a long slit which is purposely made on the top of the tube to allow it to be viewed from the front, you see a small bright star whose light is due to that particular line in the spectrum, and to no other part. The apparatus is placed at a sufficient distance in front of the photographic telescope, and these stars are the objects examined. In this way I can produce a small bright star of a colour corresponding to any of the lines in the spectrum, and the foci of these, as observed in the photographic telescope, can be measured with great exactitude.

There are, of course, small matters of detail which I have been unable to touch upon in the present communication, many of which are very important for the effective working of these instruments, and which require special treatment. I have, however, confined myself to the principal and more important parts, but I trust that I have been able to show that we have at least made a substantial advance, and it remains for us to hope that when these instruments are placed in the hands of astronomers, they may yield a rich harvest of work, and leave their mark on the history of astronomical science.

DISCUSSION.

The CHAIRMAN said he was sure that all astronomers would acknowledge that the advance of astronomy was largely due to the artists who had been engaged in the construction of astronomical instruments. The facts that Sir Howard Grubb had brought forward confirmed this circumstance, and showed that if any advance was to be made by the application of photography, they must look to the improvements introduced by those who constructed telescopes.

Mr. A. A. COMMON, F.R.S., said he agreed so fully with almost everything that had been said, that it was very difficult to add any remarks. In the earlier part of the paper, reference was made to the old saying that "much depended on the man at the small end of the telescope," and no doubt this was true literally, as well as metaphorically, but the time was coming when they would have to look more to the instrument than to the man. It was a very great comfort to find that the progress which was being made by such makers as Sir Howard Grubb, gave promise that they would soon have instruments as perfect as they could be. He had been much interested with the images of the stars produced with the aid of the clock which Sir Howard Grubb had made for Professor Pritchard and Mr. Isaac Roberts. It would have been an excellent foil to the result shown that evening to have exhibited one of the old photographs of the nebula in Orion, which he took in 1882. He then used electrical control, and in the result the stars showed as fine lines instead of dots. The control which he gave to the clock was only on one side. The clock was driven a little too fast, and the effect of the electrical control was to keep it back. It was a very good control for a certain length of time,

but the conditions required to be accurately balanced. He could not agree with the remark that the English mounting did not lend itself to this method because a large arc could not be put, for he had an 18-inch reflecting telescope of that particular form, which ought to be called the Sisson form rather than the English form. He found a great advantage from this, as it reduced the errors in proportion to the length of the arc. No one who had not worked at astronomical photography understood the importance of a good driving clock, and the efforts which had been made to produce that by Sir Howard Grubb were worthy of the greatest praise. In such a work as the celestial chart there was not a single thing upon which the success of the whole scheme so much depended as upon the accuracy of the clock. The thing was apparent when you considered the effect of the slightest deviation of the motion, and of the difficulty of following night after night by any system of eye and hand regulation. No one but those who had done it knew what it was to watch a star for an hour. One great improvement was to get the beauty of the swinging pendulum as a timekeeper brought to bear upon the very erratic movement of a circular pendulum. If the circular pendulum could be made with the degree of accuracy that a swinging pendulum could, the movement would be much more easy. In the Greenwich telescope the Astronomer-Royal made the nearest approach to a perfect circular pendulum. He had never been able to get at the bottom of the performance of that clock, though he had often tried. He did not know whether the Astronomer-Royal had ever tried it on photography, if he had perhaps he would state how it worked. He was not quite sure that the principle which Sir Howard Grubb was working on was the right one. Whether it was possible to get a better motion by less complicated means he did not know, though he rather fancied it was. The friction rollers referred to as acting under the centre of gravity were not by any means new, as they had been applied many years ago to a telescope in the Berlin Observatory. One wheel was put under the centre of gravity, and the whole thing worked in a perfect way.

Mr. E. Crossley, M.P., asked for a little further information as to how the spectroscope was applied, after it was adjusted to the particular line in the spectrum, to the object-glass, which was being tested.

The Chairman said as Mr. Common had alluded to the difficulty of keeping a star in position by hand and eye guidance, perhaps Mr. Criswick, who had had some experience in the matter, would state how he managed to take photographs without any special arrangement in the clock.

Mr. G. S. Criswick said he had not much to say except to accentuate the difficulty of working a telescope without the aid of a clock specially designed. In the English equatorial the advantage was in using a long arc to drive the clock, and when the Astronomer-Royal suggested that he might experiment with one of the telescopes in the Observatory, he chose one mounted on the German method. This had a long arc, and he found it was the clock he could best manage, though it necessitated, when perfectly adjusted, the not taking of the eye from it for more than six or eight seconds, in fact it was as much as one could do to run over to the dome and shift it. The longest time he had tried it was an hour, and he found this very exhausting. He should very much like to have the opportunity of trying the telescope with the kind of clock that had been described by Sir Howard Grubb.

The Chairman said as he had been asked about the performance of the Greenwich clock, he might say he had noticed on some occasions, when making micrometric measurements, that the clock was capable of keeping an object dissected by the wire for a considerable space of time, though he should not like to say how long. As Mr. Common had suggested, it was found that the clock was quite equal to any demands made on it at that time, and that satisfied him. There was one point about the clock, and that was, they were at the mercy of the water company, who, for reasons of economy no doubt, reduced the pressure at night, and consequently there was some difficulty in driving the clock. That was the reason there had been a difficulty in taking photographs successfully by the action of the clock alone, besides which, the instrument was not adapted in itself to photography, and the photographs taken were merely in the nature of experiments. One great advantage in the clock which had been described was that one piece of mechanism was not made to do double work, one piece being used to accelerate, and another to retard. This was a very important point; it was not necessary for the clock to have a gaining or losing rate, and to be pulled up every now and then, as whichever way it wandered from the truth it was pulled up immediately. The application of the principle to the slow motion was a pretty arrangement, and one likely to work well. It appeared to complicate the apparatus by adding to the various portions, but so long as everything went well, the divided shaft, carrying the whole train of wheels, acted as a single shaft—the parts were coupled together, and no error was introduced by a difference in the teeth of the wheels. Another important point mentioned in the paper was the question of the adaptation of the object-glass to photography, and the field of view which could be obtained for photographic purposes. This was quite a new departure in astronomical object-glasses, viz., the method of obtaining the best results over a large extent of field. It was a problem that had been attacked by portrait and landscape photographers, though their requirements were not to be compared to those of astronomers.

A great degree of accuracy was required in the object-glass. This part of the question was of nearly as much importance for the carrying out of the work of the photographic map of the heavens as the accurate driving of the clock, because if you could only take very small plates covering a couple of degrees square, the work would take very much longer than if the size of the plates could be doubled.

Mr. JOHNSTON STONEY, F.R.S., said one point which struck him as of very great interest was that means had been obtained for getting an enlarged field along with an oval form of the image at the edge of the field, which was a very great advance upon what had hitherto been done. He should be glad if it could be explained how such a form of image could be obtained.

Mr. SADLER said he had never seen such circular images of stars as those obtained by Messrs. Henry, which were far superior to those obtained by Mr. Roberts.

The CHAIRMAN asked at what distance from the centre of the field they were obtained.

Mr. SADLER said at about $1°$ or $1\frac{1}{2}°$.

The CHAIRMAN said the really critical point was to get an image at from $1°$-$1\frac{1}{2}°$ from the centre of the field; there was no difficulty in getting it at $1°$, or a little less; and the circularity of the image would depend very much upon the accurate driving or pointing of the telescope. There was also the important question of the form of the object-glass.

Mr. SADLER said the Brothers Henry used the ordinary clock arrangement controlled by one of the brothers.

Mr. J. TRAILL TAYLOR said it had been known for some time that a chromatic correction might be obtained by the separation of the elements of the object-glass, as was stated at a meeting of the British Association by Sir Howard Grubb many years ago, and he lost no time in altering a small telescope he had accordingly, and obtained chromatic correction, but at the expense of the spherical. He should like to inquire in the case of an image obtained with a chromatically corrected telescope, what would be the difference between such an image and that obtained by a telescope having a sensitive plate placed at its best actinic focus; and if there were any advantage in the latter; and as that was a constant error, so to speak, for object-glasses for distant objects, might it not be well to employ an ordinary visually well-corrected object-glass and place the plate at its chemical focus? Again, as to the photograph itself, might there not be a way of correcting the possible mechanical errors of the photographic plates? He got a number of stars not represented by those on the heavens, caused by particles of dust in the film, and many years ago he arrived at the conclusion that the Daguerreotype process was the correct one for taking astronomical photographs, there being no errors arising from the minute specks of dust, such as occurred in the collodion or gelatine film. Another thing which occurred to him was whether it would not be possible to extend the flatness of field by the adoption of a second glass specially corrected for that purpose, such as was originally introduced by Professor Petzval in connection with his orthographic lens. In his hands it had answered so well in ordinary landscape photography that he thought in the hands of a skilful optician it might also be applied to astronomy. A plano convex lens would project an image on an exceedingly round field sharp at the centre only, but by the introduction of a dialyt of a negative power placed at no great distance from the objective, the field was extended over a very considerable area, and he had satisfied himself that it was possible to obtain such a high degree of definition with an object-glass of that kind, working with a very large aperture, that from his house at Wood-green he had taken a photograph of one of those bills which used to be stuck up at the Alexandra Palace, and putting that under a microscope of such a power that it rendered the granulation of the silver image visible, which was the limit of observation for photographs, he could read the bill.

Mr. C. E. STROMEYER asked if the distortion of the stars on the outside edge of the field was due to the chromatism of the image or to the circular aberration.

The CHAIRMAN said it was not due to chromatic aberration.

Professor STOKES, P.R.S., M.P., said one might, by separating the lenses, get the correction perfect for the distortion of light for visual lenses; then by separate lenses, at a certain distance, you might get it right for the photographic rays, but the objection to that was, that if the spherical aberration was connected in one case, you produced very considerable spherical aberration in the other. It occurred to him that by choosing the proper form of crown glass, by reversing the crown glass lens at the same time that you separated the two lenses, you might get the spherical aberration corrected, as well as the chromatic aberration corrected, chemically. He made certain calculations with reference to the form of the lenses, but there was one datum which he had not got accurately, and was obliged to guess, viz., the ratio of the chromatic dispersions for visual correction and chemical correction respectively. He took what was supposed to be the probable value, but Sir Howard Grubb had actually made experiments as to the amount of the difference, and so had found it possible to carry out this plan.

Sir HOWARD GRUBB, in reply, said no doubt a long driving sector could be applied to the English form of mounting, but that it was not very convenient was evident from the fact that you hardly ever saw it done. With regard to the complication which had been alluded to, he thought a good deal of it was due to the multiplicity of wires which he had attached to the clock for the purpose of demonstration, but which were not necessary to its working. The Chairman was perfectly correct in saying that the shaft, complicated as it was, and cut into five pieces, worked as one piece in the normal condition of affairs, until some correction had to be applied. Still, he hoped that in time the end might be accomplished with greater simplicity. His experience ran in the direction that you first had to devise the machinery to do the work, and as soon as you had done that you began to simplify it. With regard to transferring the pressure to the bottom of the stand, and applying the roller in a vertical direction, that was a suggestion of Dr. Gill's, and had been applied to some German telescopes before, but in those cases, the fulcrums of the levers were in the upper part of the pillar; in this case they were at the lower part, and he believed this was an improvement, but experience would show. A tolerably slight pillar would appear stiff so long as there was no weight on the top, but if you put a heavy weight on it you saw at once that it was not so stable, and by transferring all the weight of the moving parts to the lower part of the pillar, he thought there would be an advantage. As to Mr. Crossley's question about the spectroscope, he had certainly omitted some details. In using the spectroscope you placed a small electric glow lamp in front of it, and the whole apparatus was then placed at a distance of 150 feet from the telescope; the little monochromatic image formed in it was used as a star to observe in the telescope. With regard to the correction of the lateral pencils, he was hardly prepared to enter fully into the question. You got the centre all right, but when you came to the edge there were various forms of image, according to the construction of the object-glass. In the photographic plate it generally assumed the form of an oval, with one bright end, and that bright end was sometimes in one direction and sometimes in the other, according to the form of the object-glass. Some form between the two might be supposed to give a tolerably evenly lighted oval, and that was what he was aiming at. With regard to the photographs of Messrs. Henry, if Mr. Sadler referred to the enlargements of those photographs as compared with enlargements of others, he should agree with him, but having very carefully examined the negatives themselves, he must say that he had seen others equal if not superior to them. In taking those photographs, it was a question of keeping the eye to the telescope, and the hand to the slow motion for every moment during the exposure. There it was a question of human control, here it was a mechanical arrangement. With regard to Mr. Taylor's point as to the chromatic correction of the object-glass, there were several corrections; first there was the visual one; then one in accordance with the method on which a photographic object-glass was constructed, a sort of compromise between the visual and the photographic; and a third, in which the visual was rejected altogether, and you corrected solely for the chemical rays. That was the original correction that Voigtländer used for photographic lenses. You must first have your plate, and find out what portion of the spectrum impressed itself most vigorously on it, and then the best correction would be to bring the flattest portion of the curve (shown in Fig. 8) opposite that part of the spectrum. Mr. Taylor was right in saying that you could get a larger field by using a compound objective, and if the object were to produce pictures of a nebula or a star that would be an improvement; but they wanted something more than that, something which would be capable afterwards of accurate measurement, and once you went into the compound forms, the pencils not being all central, you could not calculate the amount of distortion, and therefore it was wisely decided that no compound form of lens should be used. With regard to the plate, the whole thing resolved itself into a question of sensitiveness, and the daguerreotype was much less sensitive than gelatine. It was the advent of gelatine plates which really gave the impulse to this movement.

The CHAIRMAN then proposed a vote of thanks to Sir Howard Grubb, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

PARIS UNIVERSAL EXHIBITION.

The applications from intending exhibitors for space in the British Section of this Exhibition ought all to be sent in before the end of the present month, addressed to the offices of the Section, 2, Walbrook, E.C. They have been asked for thus early, in order that the Executive Council of the Section may be able to form an approximate idea of the actual amount of space which they should take over from the French authorities. Applications received after the 28th inst. will not be refused; but they can only be entertained subject to the possibility of space being found for them, and the total area required for the British Section will be calculated on the amount applied for before that date. Up to the present, a satisfactory number of applications have been received, and the Executive Council anticipate that the whole of the space which can be placed at their disposal will be fully occupied.

The arrangements for the British Section are reported to be, so far as they have at present progressed, very satisfactory. The Exhibition will extend over two large spaces of ground—the Champ de Mars and the Esplanade des Invalides. It will therefore, be very much larger than that of 1878, which did not take in the Esplanade des Invalides. Besides these, it will include, as in 1878, a considerable space on the northern side of the River Seine, viz., the Trocadero Palace and grounds. The two main divisions of the Exhibition on the south side will be connected by a long range of galleries running along the river bank on the Quai d'Orsay. This fine roadway is now being diverted from its usual employment and being covered with the necessary buildings. The eastern end of these galleries—that is to say, the end nearest Paris, and close to the Pont de la Concorde—will be allotted to British agricultural exhibits. The work of constructing the galleries was commenced at the western end, and consequently the British part has not yet been reached. Of the main buildings in the Champ de Mars, the largest and finest will be the machinery gallery, which will occupy the southern portion of the ground. It is a large hall of a single span, and a good idea of its size may be given by saying that it will be somewhat larger than St. Pancras Railway Station. The side walls of this are partly finished, but no part of the roof is yet on; some of the girders of the roof are now being raised into position. Great Britain will occupy a convenient position in the north-eastern corner of the building. The buildings adjacent to this are in a much more forward state; these are intended for the general industrial courts, and a large portion of them is already quite finished, including the galleries to be allotted to Great Britain. When it is said that they are finished, it should be understood that this only means that they are carried as far as the French authorities propose to carry them. The framework of the building is there with its roof, but the roof is pretty nearly all that there is; the ends are open to the winds, and the floor is at present the sand of the Champ de Mars. The shell of the building will be handed over to the Foreign Commissions for them to complete; while, in the case of French exhibitors, a tax is to be levied on them which is practically equivalent to the charge for space which is made in our own provincial Exhibitions. Of course, in all the London International Exhibitions the buildings have always been entirely completed, and neither exhibitors nor Foreign Commissions have ever been expected to defray any costs beyond those incidental to the installation and care of the actual exhibits. It is important that intending exhibitors should understand that though the actual space is given gratuitously, they have to bear the cost of constructing the building. The position assigned to Great Britain in this part of the building is an excellent one, close to the Port Rapp, the main entrance to the Champ de Mars. The Palais des Beaux Arts, which comes next to the general industrial galleries, is a building of a more solid character, and this will be entirely completed by the French Commission. At present no definite allotment of space has been made in it to Great Britain; but this will be decided upon as it is known what our requirements are likely to be. It will thus be seen that two of the best places in the Exhibition have been placed at the disposal of this country—one at the principal entrance, the Port Rapp, and the other at the nearest entrance to Paris; while in the third space, in the machinery hall, is, so far as there is any choice, in the best part of that building also.

THE CULTIVATION AND EXPORTATION OF FRUIT FROM DEMERARA.

So much has been written and said, since the Colonial and Indian Exhibition, on the regular importation of Colonial fruits into the English market, that the following notes by Mr. Jenman, Government Botanist and Superintendent of the Botanic Gardens, Georgetown, Demerara, will be of value, as bearing not on the capabilities of transit or shipment, but on the more important question of extended cultivation. Mr. Jenman says:—The attempt of Messrs. Scrutton and Son, the owners of the steamers which call at Madeira, to carry fruit home in the *Nonpariel*, in a cool chamber specially provided, was an experiment not continued by the first exporters, who suffered a loss on it. The loss seems to have been due to want of better management, possibly owing to inexperience in the immediate delivery of the fruit on the arrival of the steamer in London. This most surely might have been easily arranged, and more recent attempts are reported to have been more successful. So far as the safe carriage of the fruit in good condition is concerned, the experiment seems to have been quite successful. Indeed, if meat and fruit can be brought, as it is under similar conditions, all the way from the Antipodes to England, there is no reason why fruit should not be carried from the West Indies and Guiana, the journey from which takes less than half the time of the former. The ice ships, too, which come to Georgetown from North American ports under sail, and are three or four weeks on the way, bring large supplies of fresh meat, vegetables, and fruit. Regarding the deficient supply of fruit, Mr. Jenman points out that development in fruit cultivation would have to take place before any very important trade could be done in its export. At present, with the exception of plaintains, bananas, and limes, the production is less than the local requirements, and to some extent less than the consumption, for there is a small importation of fruit from the West Indies. Good fruit is generally dear at Georgetown, and often not obtainable at all. As a rule, much of the fruit in the Georgetown market is poor in quality, and what is good, excepting perhaps of oranges in

their season, is meagre in quantity. Except at the height of the mango season the majority of people, not only in Georgetown but in the country, eat no fruit at all but, occasionally, bananas. Oranges, for instance, which ought to be as common as flowers in Demerara, are hardly ever obtainable by the majority, and are, as a rule, as expensive as they are in England, and less common and more expensive than introduced North American apples are in Demerara in their principal season. A large part of the fruit supplied to the Georgetown market is taken by the shipping in the river.

Fruit trees require good drainage, and between the difficulty of always providing this, and the influence of the sea breeze in intensifying the severity of dry seasons, with other circumstances, it is not surprising that very little land is devoted to their culture on the seaboard. None of these difficulties would have to be contended with on the rivers. Living close on the banks, as the people generally do, good drainage is easily provided, and much of the land is sufficiently high to need no special drainage. Passage by water, too, provides the best of all means of conveyance to get the fruit to market undamaged. There is room for a great increase of fruit consumed in the colony, and corresponding opportunity for men to go into the cultivation. It should be undertaken on a scale that would pay for its conveyance to market. A good deal of fruit is now wasted, or not utilised to the greatest advantage to its owners, because it is insufficient to pay for the passage to town. Improved means of distribution to consumers are also much required. Although fruit is excessively dear, attempts to increase the supply seem to be discouraged by the distributors. In getting a high price for their fruit they probably make as much profit as if they sold a larger quantity at a lower price; hence, they discourage a condition that could only increase their labour, without increasing their reward for it. One frequently hears of some cultivator who, finding a particular fruit dear in the Georgetown market, sends down a consignment, for which from the regular vendors a trifling sum is obtained, that will not pay cost of conveyance. Fruit in the tropics is a more perishable commodity than in temperate lands, and the means of getting it to the consumer require to be the more expeditious. Possibly a good, constant supply would, by inducing a large number of people to take up the distributing business, be the best remedy for the discouraging circumstances complained of. Of course, cultivators would have to face, at first, some waste of their produce, as the new demand and means of distribution were, by the permanence of the supply, being brought into existence. Possibly, by combination, fruit-growers might effect better means of distribution to the public themselves. The middlemen (in Demerara generally middlewomen) in the fruit trade everywhere seem to be the barrier between the producer and the would-be consumer.

Pineapples.—As to the fruit that should be grown, there need be no difficulty in selection. The pineapple is a native of the land. It prefers sandy, well drained soil, of which there is any extent available, much of which is within reach of present means of rapid conveyance to market. Many of the best kinds of pineapple are already scattered about the country. There are some kinds grown by the Indians and are possibly indigenous, which, though inferior in quality to the best introduced kinds, keep longer, and may therefore be found useful to export.

Oranges.—Good kinds of these well-known fruits are available, and might be multiplied to meet the largest demand for plants. One of the most abundant in Demerara is the Tangerine, which, because of the free peeling of the rind, is everywhere a great favourite, though in flavour and juiciness it is not equal to some of the more tenacious-skinned kinds.

Mangoes.—Under this head Mr. Jenman says:—"Mangoes are not nearly so abundant in Demerara as they are in the West India Islands. This is due chiefly to the fact that from the nature of the country the tree can hardly be said to be naturalised so as to reproduce itself spontaneously, though when planted it flourishes prosperously enough. Undrained land it cannot grow upon, and the drained land which constitutes the sugar estates are too thoroughly cultivated for any tree to spring up upon them. In the days of slavery estates were generally planted with mangoes, which supplied the people, when the fruit was in season, with much nutritious food. Estates now have relatively few mango trees. Many fine trees may be seen at some of the older settlements on the rivers, having the dimensions of large forest trees. Both these and the estate trees are precarious in fruiting. In wet years they bear sparsely; in dry seasons the crops are often heavy. On the coast the sea breeze often greatly reduces the chances of a good crop when it happens to be strong while the trees are flowering. Generally the kinds are very poor. No fruit possesses so wide a range from, I might almost say, absolute vileness to the most delicious lusciousness as the mango. In some cases it is hardly good enough for hogs, in others it is food for the gods. Hence the importance of selecting the better kinds."

BRICK TEA OF CHINA.

In a former volume (Vol. xix, p. 60) an account was given of the manufacture of brick tea. At that time the export to North, East, and Central Asia was but of a small amount; since then it has increased five-fold, reaching now to about 452,000 cwt.

Finding that India and Ceylon are superseding largely their tea in the European markets, the Chinese are pushing their teas more extensively overland into various parts of Asia.

From the prolonged manipulation which tea leaves undergo, a large per-centage becomes much broken,

and thereby deteriorated in value. But this tea dust and siftings as a rule yields a stronger infusion than the finest and most perfectly curled leaves. A vast quantity of this refuse is produced in districts of the Empire so remote from the Treaty ports that some other opening had to be discovered for utilising it. Brick tea takes three forms, large green, small green, and small black.

The packages are known as baskets, being covered with plaited bamboo. The first kind consists of 36 bricks of 13 by $6\frac{1}{2}$ by $1\frac{1}{2}$ inches, weighing about 1 cwt. It is made of the coarsest leaves and upper twigs of the tea shrub, with much broken leaf and dust, and compressed by moulds or lever presses. The second quality, small green, is more carefully prepared, and fetches a higher price. The bricks are $8\frac{1}{2}$ by $5\frac{1}{4}$ by $1\frac{7}{8}$ of an inch. Neither of these forms undergo fermentation. The third quality, small black, is made from the waste dust and fibres into cubes of the same size as small green, and is usually packed with 64 or 72 bricks in a basket. Rice water has to be added to combine the substance, and to make it retain the form of the mould.

Tea is an article of pure necessity in Thibet, and fetches a high price. When coin is valueless a few handfuls of tea will procure many necessaries in Thibet. With the present moderate price of the tea raised in British India, in the valley of Assam and the slopes of the Himalayas, a great source of profit would arise to our planters and merchants by opening up a means of communication between Assam and Thibet. The comparative exports of different kinds of tea from China are shown in the following returns in piculs:—

Kinds.	1874.	1886.
Black	1,444,249	1,654,058
Green	212,883	192,930
Brick	74,791	361,492
Dust	3,504	8,719
	1,735,427	2,217,199
	231,358,876lbs.	295,626,533 lbs.

Exports of brick tea from China, in piculs of $133\frac{1}{3}$ lbs.:—

1874	74,791	1881	247,498
1875	166,900	1882	219,026
1876	153,950	1883	218,744
1877	147,809	1884	244,996
1878	194,277	1885	280,112
1879	275,540	1886	361,492
1880	232,969		

Correspondence.

POLLUTION OF AIR AND WATER.

I find the case to which I referred on the 11th inst. was one where the matter of complaint was the pollution of a stream known as the Eagley Brook, a tributary of the River Tonge, in Lancashire, in the neighbourhood of the borough of Bolton. The case is the consolidated one of Blair and Sumner *v.* Deakin, and Eden and Thwaites *v.* Deakin, and was tried in the Chancery Division on May 16th, 17th, 18th, 19th, June 27th, 28th, 29th, 30th, July 5th, 6th, 7th, 11th, and 12th, 1887. As a result it was held that where several manufacturers, having their works upon a stream, cause a nuisance to a riparian owner below them by discharging offensive matter into the stream, it is no answer, in an action for nuisance brought by the riparian owner against one of these manufacturers, for such manufacturer to say that the share he contributes to the nuisance is infinitesimal and unappreciable. The riparian owner is entitled to have the water of the stream sent down to him in its original pure condition, and has a right to take the manufacturers in detail, and prevent each one of them from discharging into the stream, his contribution to that which becomes in the aggregate a grievous nuisance, and which causes the damage complained of. The case is reported in, "57 Law Times Reports, New Series, 522," where the very able and lucid judgment of Mr. Justice Kay (the learned Judge who tried the case) is given in full. It may interest your readers to know that the case of Thorpe *v.* Brumfitt, "Law Reports 8, Chancery Appeals, 650," was followed. It seems that unless pollution of the air, by chemical or other works, is really the "deed of darkness" Mr. Fletcher in his paper states it to be, the case cited strengthens very much the existing remedies of injured interests, whether agricultural or horticultural. As regards "Smoke Nuisance in London, the Courts can relieve, but the steps which have to be taken to obtain relief are necessarily too costly for private individuals to incur them.

ROBERT MANUEL.

5, Pump-court, Temple, E.C.,
April 12th, 1888.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 25.—"The Physical Culture of Women." By Miss CHREIMAN. B. W. RICHARDSON, M.A., M.D., F.R.S., will preside.

MAY 2.—"Drawing, a means of Education." By T. R. ABLETT. Sir GEORGE BIRDWOOD, M.D., K.C.I.E., C.S.I., in the chair.

MAY 9.—"Locks and Safes." By SAMUEL CHATWOOD.

MAY 16.—"Electric Lighting from Central Stations." By R. E. B. CROMPTON. THE ATTORNEY-GENERAL, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

April 24.—"Craftsman and Manufacturer." By Lewis Foreman Day. John Sparkes, Principal of the National Art Training School, will preside.

May 8.—"The Decorative use of Colour." By J. D. Crace. E. C. Robins, F.S.A., will preside.

May 29.—"Persian Textiles." By Cecil Smith.

Indian Section.

Friday evenings, at Eight o'clock :—

May 4.—"The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab." By Surgeon-General H. W. Bellew, C.S.I.

The above dates are liable to alteration.

Cantor Lectures.

The Fifth Course is on "Milk Supply, and Butter and Cheese-making." By Richard Bannister. Three Lectures.

Lecture III.—April 23.—Our Cheese Supply. —Increased imports.—Best milk for cheesemaking. —Coagulation of milk, treatment of the curd, ripening.—Home-made cheese, Cheddar, Gloucester, Cheshire, Derbyshire, North Wilts, and Stilton.—Foreign-made cheese, American, Dutch.—Fancy cheese, Cream, Gruyere, Gorgonzola, Roquefort.

The Sixth Course will be on "Decoration." By G. Aitchison, A.R.A. Three Lectures. April 30; May 7, 14.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Richard Bannister, "Milk Supply, and Butter and Cheese-making." (Lecture III.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Kingzett, "Notes on the Manufacture of Chlorine." 2. Messrs. Cross and Bevan, "Further Notes on Electrolytic Bleaching.—Hermite's Process."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Lieut.-Col. Sir Marshall Clarke, "Unexplored Basuto Land." 2. Rev. T. S. Lea, "The Island of Fernando do Noronha in 1887."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Mr. F. C. Penrose, "The Temple of Jupiter Olympus at Athens, and Some Recent Excavations on the Site." 2. Mr. J. E. Goodchild, "The late Professor Cockerell's Connection with the Design of St. George's-hall, Liverpool."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, April 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Lewis Foreman Day, "Craftsman and Manufacturer."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. C. Waldstein, "John Ruskin." (Lecture III.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. E. B. Ellington, "The Distribution of Hydraulic Power in London."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, April 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Miss Chreiman, "The Physical Culture of Women."

Geological, Burlington-house, W., 8 p.m. 1. Dr. A. Geikie, "Report on the recent work of the Geological Survey in the North-West Highlands of Scotland, based on the field-notes and maps of Messrs. Peach, Horne, Gunn, Clough, Hinxman, and Cadell." 2. Mr. William Barlow, "The Horizontal Movements of Rocks, and the relation of these movements to the formation of dykes and faults, and to denudation and the thickening of Strata." 3. Mr. Samuel A. Adamson, "Notes on a Recent Discovery of *Stigmaria ficoides* at Clayton, Yorkshire."

Microscopical, King's College, W.C., 8 p.m. Conversazione.

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Mr. Joseph Bennett, "The Possibilities of Welsh Music."

Royal Society of Literature, 21, Delahay-street, S.W., 4½ p.m. Annual Meeting.

United Service Inst., Whitehall-yard, 3 p.m. Captain H. H. Grenfell, "The Position of the Torpedo in Naval Warfare."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. J. B. Walton, "Railways for Rural and Undeveloped Districts."

Thursday, April 26...Royal, Burlington-house, W., 4½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture III.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Preece, "The Risks of Fire, incidental to Electric Lighting."

Friday, April 27...United Service Inst., Whitehall-yard, 3 p.m. Major W. W. M. Smith, "The Mechanism of the Counter Attack."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. James Wimshurst, "Electrical Influence Machines."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Paper by Miss C. M. Whitehead.

Saturday, April 28...Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. C. V. Burton, "Electromotive Force by Contact." 2. Mr. H. Tomlinson, "A Theory concerning the sudden loss of Magnetic Properties of Iron and Nickel." 3. Prof. S. P. Thompson, "Note on the Graphic Treatment of the Lamont Frölich Formula for Induced Magnetism. Note on the conditions of self-excitement on a Dynamo Machine. Note on the conditions of self-regulation in a Constant Potential Dynamo Machine."

Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (Lecture III.)

Journal of the Society of Arts.

No. 1,849. Vol. XXXVI.

FRIDAY, APRIL 27, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and coucluding lecture of the fifth course on "Milk Supply and Butter and Cheesemaking," was delivered by Mr. R. Bannister, on Monday evening, 23rd inst. The lecturer, in thanking those who had assisted him, specially mentioned Mr. Barham, Mr. Lovell, and Mr. Stokes, who lent the large number of samples of butter and cheese exhibited at the second and third lectures; and Messrs. Baker, who lent the microscopes used to show the appearance ot milk and the lactic ferment organisms when highly magnified.

The Chairman (Mr. B. Francis Cobb) moved a vote of thanks to the lecturer for his interesting lectures, which was carried unanimously.

The lectures will be printed in the *Journal* during the summer recess.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

A Canal Conference will be held by the Society of Arts, on Thursday, Friday, and Saturday, May 10th, 11th, and 12th, 1888, commencing each day at 11 a.m.

Tickets for the Conference are now ready, and members desiring to distribute these tickets to their friends can obtain them on application to the Secretary. The ordinary Members' tickets will also be available.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 24th, 1888; John Sparkes, Principal of the National Art Training School, in the chair.

The paper read was—

CRAFTSMAN AND MANUFACTURER.

By Lewis F. Day.

The present condition of the applied arts stands in very curious contrast to their position in times past.

That is natural enough. We live in the 19th century—difficult as it would appear to be for some people to realise it. And though it might be interesting enough to compare a condition of things hopelessly past with the situation of to-day, it would not be very much to the point.

Lest, however, it should too readily be taken for granted that the existing is the normal state of things, it may be as well to recall to mind that time was when art, even applied art, was in the hands of the artist, craftsmanship in the hands of the craftsman. Now it is very largely in the hands of the manufacturer. Nothing could much more plainly illustrate the divergence between the aims of the old art and the new than that simple statement of fact.

Decorative art in general, from being an affair of craftsmanship, has become a matter of manufacture.

Here let me pause a moment to anticipate any misapprehension my use of the terms artist or craftsman on the one hand, and manufacturer or middleman on the other, might give rise to.

The subject of my paper compels me to discriminate between the actual worker, who must be presumed to take an interest in his work as such, and the provider, trader, or whatever he may be called, whose motive power is profit.

It is not proposed for a moment to imply that the double motive, in ever-varying proportions, does not exist. On the contrary, we may take it for granted that absolute singleness of purpose is quite exceptional. There are craftsmen and craftsmen, that is to say, tradesmen and tradesmen—good, bad, and in-

different, liberal, mean and scrupulous, in either class.

Only, for want of a wider vocabulary, I find myself compelled to use the terms craftsman and craftsmanship in the one sense, and manufacturer and middleman in the other.

It may seem as though the typically good craftsman were thus brought into unfair contrast with the typically bad manufacturer. That is not at all my intention. What I do mean to suggest is that the trader, as such, does not take the same ground (I should say such high ground) as the maker, as such.

The craftsman (in so far as he has any artistic qualification whatever) is bound to act upon some loftier prompting than that of making a profit. The craftsman who does not do so, is not the craftsman of whom it is spoken to-night. The manufacturer, on the other hand, who really seeks the advancement of art, is not the man spoken of to-night as manufacturer or middleman. He is something more. Let the earnest, fair-dealing, art-loving, high-aiming producer take no offence. He is praised when the craftsman is extolled; just as the greedy, slovenly, unconscientious workman shares in the blame attaching to modern manufacture.

There are manufacturers who are all that craftsmen could desire. They are possibly—indeed I hope they are—more in number than one has any notion of. Of such is the ideal manufacturer. But there are others who care nothing for art and only flourish about the word. Some there are who fain would help art, but know not how; some are faint-hearted; some are vain, some ignorant, even of their craft. Some profess to care for nothing but "results"—which with them means not perfect work but profit.

It is difficult not to look upon the good qualities of the manufacturer as being in some degree due to his sympathy with craftsmanship, and to the bad qualities of the workman as due in a measure to the condition to which manufacture has been degraded.

Craftsmanship, as I understand it, would in itself make a man thorough in his work, fair in his dealing, intelligent in his appreciation. Manufacture, as at present understood, will scarcely hesitate to scamp what work it can, gives as little as possible at the price, and judges art strictly according to the selling price in an ignorant market.

The benefits of commerce are patent. Its praises are part of the cant of the day. One would think, to hear them, there was no God but this God, and the press was its prophet.

The simple truth is that commerce has popularised art. It has paid the artist, as it would say, handsomely; but it has encouraged on the whole the less worthy form of art; and even that it has persisted in lowering to the level of supposed popularity. And by its very force, the power of wealth and organisation, it has compelled the artist to submit to its direction and dictation.

The craftsman, it is often said, owes everything to the middleman, to the capitalist. What would he do without him? Very likely he would starve. What then is the employer but the benefactor of the employed (who but for him would be the unemployed) providing work for him, paying him regular wages, and so on and so on?

Well, the power of the middleman does not precisely prove his beneficence. If the workman cannot live without him, that is not in the nature of things, but because the employing class has made itself so strong a position that it can dictate terms to the employed: "work for us, or you shall not earn a living by your handiwork." It is only here and there a very gifted man or an exceptionally fortunate one who can take his stand independently. Society and law allow the strong to assert his mastery over the weak, and have done so always from the days of the black-mailer downwards, our boasted civilisation notwithstanding. It is contended that it is just a question of free contract, that if the craftsman is tempted by the producer to submit his art to the consideration of £ s. d. that is his fault: it would be hard lines not to be free to sell yourself to the Devil if you liked. There would be some truth in that were a man free always to choose between modest pay for his best work and good pay for worse. He has often to choose between no work at all and such as is offered to him. That may or may not be a very wholesome state of things commercially and morally,—but certainly it does not make for art. Nor does it tend to strengthen friendly relations between the manufacturer and the man who makes. And in the strife between the two art has a poor chance of survival, though it be the fittest.

It is the eternal excuse of the middleman that he must live. The artisan might answer that he saw no absolute necessity for that—least of all at his expense. But how that plea of "living" is misused! A good deal is to be excused to the man who literally finds it

hard to keep body and soul together; but he is more likely to be found amongst the employed, or the out of employ, than in the ranks of the employers.

And of the manufacturers who succeed how many think that they owe something to the art or craft by which they have made money? Do many of them of their means risk something for its advancement, apart from the profit it may bring them? They have been known to form a ring to keep up prices or keep wages down; but they no longer combine to keep up the standard of craftsmanship. Even the funds of the great trade guilds, whose glory it was to do that, no longer go to the encouragement of the crafts from which they take their name—let alone the private resources of the liveryman.

When the great guilds flourished, artist, handicraftsman, and tradesman, were practically, if not actually, one. There never was a time when the artist was not influenced by commercial considerations. Sometimes he was very much indeed a man of business. But so long as there was anything of the artist about him, there was always something at work on his conscience to urge the interests of art, even at the personal sacrifice of more material interests, and to hinder him from looking at his work purely from the pecuniary point of view. His faith in himself, his very vanity made for art. So he was encouraged always to do the workmanlike thing, in the belief that the best was best worth doing. And his very persistence gave it a chance of succeeding which now-a-days is not always open. For who will ever believe quite so fervently in the swan-like attributes of his geese as the parent gander?

We are all too eager to make fortunes: no one is content to make a living. But the craftsman, if he were allowed to get some satisfaction out of his work, could take contentedly the modest pay that would supply his actual wants. The manufacturer whose interest in his work is wholly pecuniary, who possibly looks upon his labours in the office as so much grind, must needs earn money to spend in whatever may be his idea of compensation for the joyless task of getting it.

It is one of the worst features of the business creed that it takes no account (perhaps can take none) of all that may be got out of good work besides money. That is the accepted measure of profit and that alone.

To the craftsman's thinking it is a false standard altogether. He does not deny that "the job must pay;" but he does deny that there is occasion for any one to grow rich over it—even the artist.

The one thing that strikes us about the accessory art of ancient, mediæval, and all times down to a century or so ago, is that, whether we care for it or not, someone did, presumably the owner, certainly the maker of it. Those seem to be the essential conditions of good work, that maker and buyer should be interested in it. The conditions of modern manufacture make that more and more unlikely.

The hopelessness of the situation has made Mr. Ruskin turn preacher, and driven men like William Morris and Walter Crane to espouse the desperate cause of Socialism.

Sympathising as I do entirely with that spirit of revolt against the unequal conditions of the day, a spirit especially noble in men who have no selfish interest at stake, I cannot, I confess, see any hope in the remedy they propose.

For all that, they are right, I think, in judging that the disease is in the social, not merely in the artistic, conditions of the times. What hope of thoroughness when every commodity is cheapened and every trade is sweated; what opening for art, which should be reticent, in this era of swaggering advertisement; what chance for beauty when the craze is for novelty? It is difficult to speak on this subject with anything like moderation. It needs to be realised that the first condition of artistic success in manufacture is that the manufacturer should care for art.

Moreover, it is essential that he should be at least a past-master of his craft. It has been a perpetual wonder to me to find how few of the manufacturers I have had to deal with really know the wheels in their own works. That comes of the conditions of modern manufacture, and, understand me once for all, it is those conditions I find fault with, not the manufacturer, who perhaps can help himself as little as the craftsman.

The conditions of modern manufactures place the initiative in the hands of persons who do not necessarily know anything of art. What they may claim to know is the market; and they dictate what shall be provided for it.

Whether they do know, whether anyone knows, or can know, what will take, is a question. I doubt it. Though undoubtedly a man of energy can, and does, force his choice upon the public. What the producer believes in, therefore, he is likely to be able to sell.

To him we owe it that the even course of art is disturbed by a rapid succession of what

are called styles—fashions foisted upon us on the pretence that this latest novelty is what, as respectable members of society, we are bound to purchase, whether we want it or not. Things are no longer made "to supply a want," as the advertisements say, but to stimulate one. The keen tradesman will tell you, with something like scorn, that any fool can sell what people want to buy,

To him (or more properly the state of things which puts him where he is) may be attributed to a great extent the galvanising of dead fashions. The initiative being in the hands of some one who has no claim to invention, he must fall back upon the repetition of something that has been done.

We see some of the ill effects of our system wherever work is in the hands of a man personally incapable of its execution. Such a one must perforce resort to the poor expedient of instructing the artist to work in the manner of this or that period, this or that craftsman,—the result of which "historic" inspiration is not, and can scarcely be inspiriting to behold. Dreary as it may be, however, it is cheerful as compared with the product of a quite inventionless brain wracking itself to think what, in the name of profit, remains yet to be done.

There is only one more dreadful thing than that—viz., the efforts of the same imagination, if imagination it can be called, to meet the demand for the artistic—as the producer understands it. Perhaps the worst thing that could happen to art is that it should be fashionable. That affectation of art, in the interest of the shop, which was known by the name of æstheticism, was anything but helpful to the cause. The cheap parody of the beautiful brought into disrepute the very notion of beauty in design. We have not yet recovered from its effects.

I look upon fashion, that is the false ideal of novelty instead of use or beauty, as absolutely incompatible with art—and fashion is, or seems to me, almost inseparable from the current idea of trade. It is to the pecuniary interest of the wholesale producer to substitute for all test of art or workmanship a standard of merit of which he is the judge. And no one certainly can know better than he whether a design is the last thing out. What is it to him though it be the ugliest and stupidest so long as we accept his standard—and his novelty

You may say, the only remedy to such a state of things is to educate the purchaser. That is very necessary no doubt. But it *is* worth noting that the craftsman would not of himself encourage this crazy idea of novelty. (We none of us really *want* an entirely new set of patterns every year.) And the first thing a truly educated public would do, would be to get rid of superfluous middlemen, meddlers, and muddlers.

Let me give an illustration of the way art suffers from being so exclusively in the hands it is in. Suppose any new method of work or style of design, such as may be revealed in the importations from a country newly opened to us. There was something of the kind when after the Paris Exhibition of 1867 we first had the opportunity of seeing Japanese art in its perfection. Again more recently there has been an influx of Cretan, Rhodian, and other Eastern art in the form of embroideries, of Indian, Persian, and Arab art in the shape of carpets, pottery, and metal-work, and so on. Now from each and all of such imports a plain craftsman would be content to learn, assimilating whatever was available for his use, broadening by so much his principles and varying by so much his practice.

What use does the manufacturer make of his opportunity? He sees in it only an occasion for a new fashion. Here is an unknown art, here are unfamiliar forms to be copied, a fresh vein to be "worked," as he says—and, in the heedlessness of ignorance, he works it, and very soon works it out. That may answer his purpose; but it answers no other purpose in the world. Surely the folly of working out a mine in that manner is as enormous as the selfishness of it. Reaction comes in a very short time. Folk sicken of the repetition even of a good thing. The fashion goes out as suddenly as it flared up—and who, let me ask, is one jot the better for it? The clever fellow who worked it! Well, I for one protest against the hideous selfishness of the whole business. I doubt if it be essential to trade—but, if it be, then let art sever itself without more ado from a connection which would drag it so low.

Let the man of business follow his own sense of commercial morality. He has been heard to brag that business is business, and that sentiment has nothing to do with it. Well, sentiment, thank heaven, *has* something to do with art, and without it you cannot get so much as good craftsmanship. Whoever lays the remotest claim to art cannot regard it as a matter of business merely, nor as a matter of business first. He may have

for a while to put business before it: it is his first business to pay his way, and provide for those who may be dependent upon him. But, his livelihood once assured, his craft comes before his pay, his art before his ease—or he is no craftsman, no artist worth the name. It is because I think the craftsman owes something to his craft, and is bound to sacrifice something to it, that I regret to see the control of craftsmanship so entirely taken out of his hands by men of business.

It is no fault of the business man if his belief in art is not of the firmest. It fluctuates naturally with the market. The wonder is, not that he fails to patronise what is of high artistic value, but rather that he ever takes up a really good thing. For whatever is characteristic or original in design, whatever removes it from the ordinary, removes it also from that safety which is the prerogative of the commonplace. In the very qualities which have power of exceptional attraction lies also the possibility of repulsion.

Happily, there are men of business who believe that art will pay, if only in the form of prestige; who are content perhaps to lose money on artistic work which, though it may not itself sell so well as the common run of things, will yet do credit to the producer, and attract to his warerooms purchasers—no matter what they purchase. Even such a man may not have any liking for art. But unless he have some personal interest of a not altogether commercial kind, he is hardly likely, however good his intentions, to carry out a design in the spirit of the artist. He is tempted to make a compromise between artistic and popular demands. It is a common thing to hear a man protest that art does not pay,—he has tried it, as the theatrical manager tried Shakespeare, and found it spelt bankruptcy. But as in the case of the drama there came eventually a manager who found that he could make Shakespeare fill the house, so in the case of design there came a producer who found that he had no difficulty in disposing of his works of ornamental art. And in neither case was there anything like tempting the public with their favourite bait of cheapness. But then it is true that both Mr. Irving and Mr. Morris happen to be artists. *If* the manufacturer cannot make art pay, that, from the artist's point of view, is the very best of reasons for getting rid of him. His *raison d'être* ceases to exist.

The manufacturer stands at the disadvantage of not necessarily knowing, as the artist must, what is art. He accepts designs that are not really of any artistic account, or he produces them ill, spoiling them by all manner of uncalled for concessions to popularity. In a half-hearted way he tries to catch two opposite classes of purchasers—and, more likely misses both.

In the matter of art all compromise with vulgarity is fatal. Coarse art may catch the million—I do not know; I only doubt if the million is quite so insusceptible to refinement as the producer seems to suppose—but this is clear, that the one touch of vulgarity which is supposed to make the purchasing world kin, effectually scares off persons of culture, and so stultifies the whole proceeding of any attempt at art. It is idle to adopt a style of design which is neither tasteful enough for the one class of persons, nor loud enough for the other.

Whenever I hear of the manufacturer who has tried art and found it fail, I wonder always what chance he gave it. Did he know art when he saw it? Did he bring out the best designs to be had? Did he produce them at the right time and in the best way? Did he offer them at a fair price? Did he employ salesmen who were capable of appreciating their superiority?

It is no use doing things by halves, or at the wrong time, or in the wrong place. It is not of much use, for example, casting art before advertisers. Manufacturers have been known before now to offer the most delicate work to the most ignorant buyers, and clap-trap to those who knew; to make beautiful designs hideous by outrageous colouring; to keep back a new thing exactly appropriate to the hour, and bring it out a season or two later when it was stale and accordingly not profitable. Have we not all of us seen good things spoilt in the producing, and abominable things produced in the misused name of art? Have we not seen half-heartedness and ignorance, and pettiness fail? And have we not seen those who really are adepts in their craft, who have faith in it, and back their faith, make for themselves a position which should be enough in itself to answer the pretence that art does not pay? Once more, the artist can make it pay, if the manufacturer cannot.

That undue sub-division of labour, which tells so against craftmanship, comes of what we call manufacture. I am not one of those who go dead against all sub-division of labour. Something like specialism is inevitable, and necessary to success in the present day.

Logically it is right enough that the man of inventive faculty should be set to design, the patient and careful executant to carry out, the clumsy hand to do the rough work, and the delicate one to finish, and so on. That is all very well as far it goes, and craftsmen sort themselves more or less after their kind. Because a man is content to do one thing and do it well, it does not follow that he is not conscientious in his work or not interested in it. Only the more irritable race of artists, by nature impatient of that monotony of occupation which to the more plodding workman may be altogether congenial, cannot but feel for anyone compelled to do what to them would be intolerable drudgery. Some of this compassion, however, is probably thrown away. There will always be workmen who sit down with a sigh of satisfaction to a batch of repetition. Besides, we all really like doing what we know we *can* do—and we are not all of us inventors.

The manufacturing mind seems unfortunately not to realise how easily the principle of subdivided labour may be carried too far; and drives the idea, and the workman, to death. This *is* the fault of the system of manufacture; for the most impatient of designers has dull periods when he would relish the hum-drum of mechanical occupation: every craftsman would be the better for occasional change in his work and, left to himself, would allow himself that very necessary relief. Manufacture works the willing faculty so hard that it exhausts itself. No need to say how art suffers from such pressure.

But for the intervention of the non-artistic capitalist there would be no difficulty about machine-made art. It would settle itself.

The tendency is always towards more and more perfect tools: and in so far as the machine lent itself to the purpose of art the artist would readily adopt it. Where it hindered him he would never dream of using it. The abuse of machinery is owing to a misapprehension as to what is, and what is not, good work. Many a producer, for example, thinks that the harder the execution the more perfect it is—just as he fancies that finicking detail constitutes finish. The wholesale evil is wrought, not so much from want of thought, as from want of knowing wherein lies the quality of art. *That* is the trouble—not the machine, which comes in for all the abuse, but the ignorant ideal which mistakes the precision of the machine for something more perfect than the handling of the craftsman.

The misuse of machinery, its use, that is, by persons unskilled in craftsmanship and unappreciative of real perfection, accounts for much of the dullness of modern design. For the racy vernacular of the workshop is substituted the smooth commonplace of the factory—in which there is neither spontaneity nor gaiety, no room for the accidental or the incidental, none for a happy thought, scarcely for a happy turn of expression. The impromptus of manufacture bear evidence of careful rehearsal.

It is odd how his pecuniary interest will stand in the way of a capitalist's appreciation of artistic quality. Very possibly my artistic interest blinds me equally to the merits of manufacture—as you will not forget to remind me presently. Not long since I heard a man dilate most appreciatively upon the charm of a certain looseness of line and inequality of surface indicative of the hand of the workman, contrasting it with the dulness which is the stamp of modern trade work. Yet, when it came to the comparison of hand and machine work in another industry, he could see absolutely nothing to admire in what he called the imperfections of handwork. But then he had made his fortune in the production of this last class of manufacture. That explained the mystery. His power looms left nothing to be desired.

Another evil of the present system is that it tends to the multiplication of intermediates, in so far hampering art. It is of the essence of a good understanding between the producer and the public that they should come directly in contact one with the other. Where this is the case, there is usually no great difficulty in working together. The intelligent craftsman will be sure to impress the buyer, and the well-informed buyer to exercise a wholesome influence upon the workman.

It may not in every case be possible to bring the two together—I only wish it were—but at any rate it is desirable that intermediates should be reduced to a minimum.

For, assuming them all to be enlightened, careful, earnest, and honest, instructions that go from mouth to mouth always get garbled in the end. There is an excellent illustration of this in the game that is sometimes played. One writes down a story—which he reads to A. A goes out of the room and repeats it to B. B relates it to C, and C to D, and so on to the end of the alphabet—and the last state of that story as Z writes it down, is something so inconceivably unlike the original that it is

difficult to believe that the tellers have acted in good faith.

Under existing commercial conditions a similar fate befalls the demands of the public before ever they reach the actual maker of things.

And when we come to realise how in the instructions to him all manner of terms, vague or technical, are used and misused by the many intermediates, the hopelessness of the case is appalling. Only think what is understood by Early English, Queen Anne, Classic, to say nothing of such qualifying adjectives as handsome, elegant, artistic, and so on!

A friend of mine tells a capital story of how he went into a West-end shop to make a purchase, and not liking what was shown to him, asked if they had not something better than that, something with a little more character in it—the designs were all too commonplace. "Commonplace, sir," said the shopman, "I assure you, sir, they are nothing of the kind; we sell thousands of them!" Fancy that man giving instructions as to the kind of thing in demand. The demand of the public! Why the public has but the ghost of a chance of getting what it demands. It is not what the public demands, but what the by no means necessarily enlightened purveyor imagines to be in demand; and his imagination naturally takes the direction of his personal preferences.

So much difficulty is there in making your wants understood, that the public has ended in acquiescing, and taking what is provided. And then anything like a ready sale is supposed to prove that the popular taste has been hit! I don't believe the popular taste is half so low as it has been painted. We buy the best we can get—not but what we would have preferred something much better, had there been any chance of getting it.

It was explained to me the other day by a manufacturer to whom I vainly endeavoured to show how very unregenerate he was, that he was only the mechanism by which, in the present complicated system of society, the appreciation of the public was conveyed to the artist. That, I need scarcely repeat, is very far from my view of his function. But in any case we are beginning to find the mechanism cumbrous and complex to absurdity—in fact it seems to be chronically out of order.

In one respect the middleman does come between the artist and the public in the guise of a mediator. The public can bargain quite frankly with him, and can even depreciate the thing to be bought (and your buyer dearly loves to depreciate) without ruffling the susceptibilities of the maker.

Grant that the intermediate does save a certain amount of friction, by that very loss of friction we lose the heat necessary to perfect production. In plain terms, the artist would be best inspired by direct contact with the public.

The predominance of the universal provider makes it well-nigh impossible for one to get work done by the craftsman direct, even if one can get at him.

To begin with, the administrator buys up the workman, who cannot afford to run the risk of defying him—not but what there are some at least in a position in which their subservience to him is something like cowardice. Then when you have found a man to work for you, he cannot of course compete in price with the wholesale man. Moreover it takes time and trouble to see after your own work, and folk are too lazy or too busy to do so. What a lot of our business is mere busy-ness, not to say busibodiness! If we delegate the trouble of transacting our affairs we must be prepared to pay the delegate; and we do pay for it, if not in money. Whether he is not too well paid in proportion to the actual maker is a question. I think he is. The manufacturing system, it must be allowed, has made it very hard to get good craftmanship, or for the craftsman to do his best. Not that the jerry workman is a product of the 19th century, only it was reserved for this generation to let him so entirely swamp his more conscientious competitor.

There is no lack of persons who talk about craftmanship and its dignity; it is a sort of fashion just now in some quarters. But we do not find any large proportion of such persons helping on craftsmanship in the only way they can help it, that is by going to the craftsman and encouraging him to do his very best. It is the custom rather to seek out the workman, less with a view to the bettering of the work, than in the hope of saving one's own pocket.

That is only another form of cheese-paring. Craftsmanship worth having argues a price which will allow the craftsman to take adequate time over it;—and what might be saved out of unnecessary brokerage would suffice amply to do that.

Time, by the way, and the need of keeping time, are all-important conditions of manufacture. Whether they are really so important as

we assume them to be is another matter. *Is* it of such vast importance that your drawing-room should be finished and furnished by next Tuesday week or your new dress delivered to-morrow? Is it of *such* moment that it is worth the sacrifice, I will not say of art, but of quality? We have determined in our wisdom that time is money—is money, then, everything? Work done against time is not work at its best; and the conditions of manufacture seem to become ever more and more exigent in this particular. Might not the very pace we are going at, head-over-heels, be taken to indicate that we are going down hill?

For all the drawbacks to the present arrangements, there *is* a certain obvious reasonableness in it. The strain of business now-a-days is so great that it requires all a man's energies to conduct it. Artists who enter trade with the best of intentions get drawn into the whirlpool, and find that by degrees they devote themselves less and less to art, and more and more to management; until eventually they are mere administrators themselves. That seems scarcely to point to any possibility of the craftsman becoming again as of old the master workman. To steer a business on the modern scale is about as much as one man can do. The more of a master the less of a workman he can be. What might be feasible is co-operation. Capitalist (if we must have capitalists), administrator (if we cannot do without administrators), and craftsman (if he is to be allowed to survive) might very well combine, each, in his way, helping the other; the one saving the other from bad work, waste of energy, or financial failure, as the case might be.

It is a pity that the craftsman is not sufficiently esteemed by the other two for them to think it worth while to admit him into anything like equal association with them. They have usually the power to keep him in a subordinate position. He is the hand only, they are the head—as though in any art or craft the hand were not an equal factor with the brain, as though the two could ever be separated!

The subordination of the workman may help to fill the pockets of some who don't do much work, but it will not help on craftsmanship, and in the end it will not prove to the advantage even of the manufacturer. For the basis of success in manufacture is, was, and will be, good work, and without it our manufacture must go from bad to worse.

It is the custom to take it for granted that the artist is of an unpractical disposition. That is much too wholesale an assumption. Only a small per-centage of artists belong to the race of dreamers—too small a per-centage perhaps. The more capable artists are, as a rule, capable men, quite distinctly practical. Even of the poetic it may be remarked that they are often acute men of business. But, allowing for something in the artist that is not calculated to ensure his success in trade, inasmuch as he is a *craftsman*, he is eminently qualified to conduct his own affairs. The quick intelligence, the promptitude of resource, the patient industry, the real interest in his work, the belief in it, and the determination to perfect it, implied in craftsmanship, are all so many qualifications for business.

We have all of us known artists born to dream their way through the world; but they were not usually very excellent craftsmen; their intention was always so much better than their performance. But who ever yet came across a masterly workman who was not very well able to take care of himself? So far from his failing on the side of impracticability (how *can* a good workman be impractical? it is a contradiction in terms) the craftsman is in danger of becoming too much a man of business. Yet, inasmuch as he is an artist, it will be assumed to the end of the chapter that he is scarcely endowed with common sense—just as we go on making the stereotyped distinction between rhyme and reason, as though some of the very wisest of words had not in all times taken the form of rhyme!

We are told of the "enterprising" tradesman: the epithet has been, as it were, appropriated by him or by his eulogist. My experience is that he is *not* enterprising. He is always demanding something new, indeed; but when he gets it he has seldom the pluck to produce it. What he really means by novelty is not originality at all, but something not of last season, just so slight a variation upon it as he thinks safe.

Manufacturing enterprise would appear to take mainly the form of over-production. It is this keen class of business men who imagine they have only to increase their output to increase their profits in proportion—who overstock the market and bring down the prices of their own produce.

It is the proud boast of the manufacturer that he creates an industry. To keep his industry going, he is always thinking what new want he can encourage in us; and so the frivolity of manufacture is fostered. Of making

many useless things there is no end. The poor blind thing we call the public wants no tempting to buy: it needs, on the contrary, to learn that it does not want a great part of what it has already. Mr. Morris did not overstate the case when he declared that he never went into a drawing-room that would not have been vastly the better for the clearing away of one half its contents.

If people only felt the beauty of simplicity, the comfort in it, the possibilities of art that lie in it!

Commercially it might not answer the purpose of the craftsman to press this upon them, any more than it would answer the purpose of the manufacturer. But his interest extends beyond commerce. He would be more than content that there should be less demand, if it were only for that better work so much better worth doing.

If it did not amount to pretty much the same thing, I would say it is time the copy-book was altered. The root of all evil is not riches but competition. The manufacturing idea of rivalry is a competition in price, which means in the end deeper and deeper depreciation in quality. The ideal of craftsmanship is a competition in quality, involving perpetual improvement. It comes naturally to the man of business (or at all events use is second nature) to ask of everything how much per cent. it will bring in. The consideration that occurs to the artist is whether it is good. The one asks who will buy, the other thinks of what he has to say.

When the craftsman and the man of business meet in one person, or when they are working together as one man, the possible result (I imagine the man or men to be sane) is something like a just balance of good work. Artistic enthusiasm and commercial prudence check one another. The wants of men in general, as well as the mood of the particular workman, are likely to be taken into consideration.

Why should capital and labour be at odds? They would not be, but for the despotism of King Capital, which is not wholly of the beneficent order. It is not without reason that labour is more or less in revolt. It would be but policy, to say nothing of justice, to grant it a more liberal constitution.

There has been loud lamentation over the depression in trade and the decay of manufacture. It is time that trade and manufacture made friends with the crafts. Therein lies the best hope alike of manufacture and craftmanship. Failing that, when manufacture gets to pay so badly that it is worth no one's while to continue it, the craftsman may take up his tools again—if he has not forgotten their use. It would be a sad solution of the difficulty to look forward to; but it is just possible that Trade's extremity might turn out to be Craft's opportunity.

DISCUSSION.

The CHAIRMAN said Mr. Day had touched at the root of a great many problems which were very difficult to solve, but he was not at all sure that co-operation would be an efficient solution. He did not think the artist was strong enough to stand on his own legs. It did not appear to him that, taking a lesson from the last century, when there were more patrons and fewer publishers, that literary men were any better off. Art, again, was then very independent of the dealer, who was very much carped at; but on the other hand, in our day he had caused a Philistine generation to believe in the value of ideas, and that there was something in a picture beyond the value of paint and canvas. He was not at all sure that the output of art work in the present day would have been so great and good as it was but for the dealer. How to get rid of the capitalist was a question to which he did not see the answer, though he thought a great many middlemen might be dispensed with—the salesman, with whose ignorance so many must have been very much irritated. One solution of the difficulty might be found in a much wider extension of education in sound principles amongst buyers. He remembered, in the early days of the Lambeth Pottery, walking down Fleet-street with Mr. Doulton, and seeing some of the pots which they had recently produced in a shop window. They went in, and were told that these pots had been produced under Mr. Ruskin's personal supervision, that there was not one which had not been copied accurately from a British Museum specimen of German origin, and that in fact all these pots were pronounced to be the most excellent things by men who were the highest authorities. It was a highly respectable establishment, and had a respectable shopman, who had no doubt sold many pots by telling these extravagances to customers; but it was evident that the purchaser was considered to be next door to a fool, who had no judgment of his own. He told the story to a friend, who informed that he had heard exactly the same thing from a shopman in Bond-street, so that it was evident that it answered very well at that time. Sir Henry Doulton and himself had some power of judging for themselves, but he felt sure that, from Fleet-street to Bond-street, that this story answered very well, and that buyers were so ignorant that they required to be tempted by these appeals to their credulity to buy a thing

which to a man of taste was obviously both excellent and cheap. He had trained many designers, amongst them one who had a very fine taste in jewellery, but not long ago he consulted him as to how he could get to Australia, as his trade was deserting him. He told him that twenty years ago there was a certain originality in certain workshops in Clerkenwell; and there were certain masters who were expert in their own line, and produced characteristic work, but that now they were practically all swept away; that purchasers went to the stores for jewellery, which was made in Birmingham tons at a time, all stamped out in moulds, and the customers at the stores did not desire anything better. If the taste of the purchasers had been a little higher, they might have refused these mechanical productions, which no one of any taste could take any pleasure in. No doubt the stores could justify themselves by saying they provided what would sell. But here the only remedy would be an improvement in education. He did not see that there was any revival in trade, and artists and designers would still have a hard time, but still there were gleams of hope. The wrought-iron art industry, which had come to great perfection of late years, had a certain life in it at different centres. There the workman was certainly not degraded by being asked to produce tasteless or incongruous things, for the present race of art-smiths were formed out of the ordinary workmen, and in the case of this industry there must be some separation of hand and brain. The designer had to understand what the workman could do, and the workman did it, but it was not mechanically copied. In a piece of art ironwork there would be a great many panels very much alike, but each workman had his own perception of the curve that a scroll contained. This was a large and growing trade, and showed an indication of a better state of things; and the manufacturer in that business had not yet grown to be an all-absorbing universal producer. It seemed to him that there might, with advantage, be something like a trades union for the protection of designers, not necessarily against the manufacturer, but against the mere middleman. It was being tried in Paris and in Vienna, and in the former place he heard it was very useful. A manufacturer could go there and ask for a design for any manufacture, designers being attached to the central institution capable of every kind of work. This would be an advantage to the manufacturer, as he could go there for designs, and this would help to encourage talented young men.

Mr. HUNTER DONALDSON thought all must concur heartily in the general statement made that, as a rule, manufacturers were very ill informed, and he could say so with all the more confidence, being one himself. There was an unfortunate lack of artistic faculty among even eminent manufacturers, and it was greatly to be regretted that there were not in this country men like Barbetti in Florence, and Fourdinois in Paris, who were at once admirable artists and excellent workmen; there were many establishments on the Continent which admirably exemplified what Mr. Day had described. There was, however, some improvement even amongst English manufacturers, though there were some few miserable men earning large sums of money without the faintest perception of art, or any love for it at all, their one idea being to make a profit. Nevertheless, in London at all events, improvement had taken place. He remembered a house which, twenty-five years ago, had, as its one artist, a very gifted little man, who was put in a little room in the most obscure part of the premises, where it was thought he could produce all that the establishment required in the way of art. He was kept there until he ultimately faded away and died, the art itself having died long before. Happily, a change took place in the house; it was felt that a greater taste for art was spreading, and that, at any rate, they should assume a virtue if they had it not. Artists were engaged, one of whom, a specially gifted man, went a little wrong in his head, and threatened to shoot the principal, which was a little discouraging; but they went on, until ultimately that house paid £1,800 to £2,000 a year to the artists employed. There were not a few other houses where artists were liberally paid, and he thought the manufacturer, perhaps, deserved a word or two in his defence. He quite admitted that the intervention of the middleman—the salesman—was undesirable; but with regard to the manufacturer, Mr. Day, as a practical man, must know he was indispensable. You must have as principal a man with some other qualities than those of the artist. You had to combine a great number of things in one object; it might be steel, silver, copper, and ivory, and the knowledge of where and how these things could best be procured and combined was what the artist, as a rule, did not possess; though there might be special exceptions. You wanted a manufacturer who, while sympathetic with art, knew how to procure and combine most effectively such materials as he had referred to. The principle which seemed to underlie the paper was, that there should be co-operation between the artist and principal: that the artist should not lose all interest in his design when he had made it, but that he should feel himself to be incorporated with the house, and have a direct pecuniary interest in the success of the business with which he was associated. And he would extend the same idea to the workmen. Many of our political and social differences would disappear if there were a more general recognition on the part of employers of their obligations to the men they employed, from the artist downwards; and if the leaders of the various departments were taken into a kind of partnership, as they were by Leclére; if they all combined, not merely for making a profit but for the honour of the trade; and if each derived a fair proportionate advantage from the success of the house, it would give that stimulus to art which they all desired, and would result in a very material revo-

lution in the present aspects of the capital and labour question.

Mr. ORRINSMITH, as a manufacturer, wished to say a few words on that side of the question. Having been an artist for many years before he became a manufacturer, his sympathies were with artists, and almost all that had been said as to the relation between artists and manufacturers was quite true; but, at the same time, it was exceedingly difficult to mend, because the artist could not fight his battle with the world without the assistance of the capitalist, who was the manufacturer. All they could hope to do was to modify the conditions, not to change them by any great revolution in the arrangements of trade. The salesman, perhaps, might be eliminated altogether, but that suggested a little difficulty to a man of business. There was a certain machinery necessary for getting at the public, which was not a very pleasant machinery to drive, and men capable of better things would not be willing to undertake it; the artist despised and disliked it above all things; and the capitalist often disliked it equally. He was content if he got a return for his money, and did not wish to go into the sordid and vulgar business of pandering to the bad taste of the public. It was difficult, therefore, to do without the multitude of distributors. And if you had distributors you must allow them to have their own views, though they were often erroneous. If a man owned a place where he could expose the wares he had for sale to great advantage, and bring them before the public—who would not turn up a street to seek a good thing—you must leave something to him. You wanted to get at the people, you wanted their money, because without money to support the manufacturer great artists could not be employed; and the amount of work which could be done if it were left to the artists, without the aid of these other men, would be exceedingly small. If you had a glorious creation of art, you wanted to make as many replicas of it as possible, to spread it over the world. The only way to pay a good price to the artist who produced it was not to get a big price from the public, which meant a small sale, but to get a fair and moderate price and a large sale. The machinery for doing that was furnished by the salesmen. The question of taste was a very difficult one. The manufacturer had a certain power of directing it, but a great deal came from the public, and in spite of all the efforts which had been made for many years, the question was still very doubtful. You might get a piece of work from a good man, and get it done in the best manner, and then the man who had to pay for it thought himself a better judge of it than the maker. There might be a figure on it, and he would say he did not like it; and if you told him the figure was after Michael Angelo, he would only reply that he had always considered Michael Angelo a much over-rated man. If your customer were a man of taste, you could work for him with pleasure, but if he were a vulgar man he would insist on criticising and altering the work, and would often spoil it. One of the best tests you could take of the bad taste of the public was to be found in the crockery shops. The ugliest forms and the worst colours and decorations were to be found there, and if you did find something at all tolerable, it was generally put under the counter as being unsaleable. Instruction for the public, therefore, was more important than for the manufacturer. The middleman was more one of the public; he was not a manufacturer, or necessarily a capitalist, and if you could instruct him you would do a great deal, but you must inform the whole class of buyers before you improved the distributors. As to bad work, the great cause of it was bowing down to the Moloch of cheapness, which ruined everything, and so long as you had competition that could not be avoided.

Mr. WARNER said it had struck him, on listening to the paper, that the great difficulty for the manufacturer was to get really original designs. They were overdone with designs of second, third, and fourth-rate quality, produced by men who were not craftsmen, and did not understand their work. The number he had submitted to him was very large, but many of them he could not use. The South Kensington Museum was so full of hints that you could get no original work at all. Not long ago he bought a design which he thought had some signs of novelty about it, and in three days' time another man came with the same design, far better drawn, which he was obliged to purchase also, for his own protection. On seeing it the second time, he recollected what it was, and the man said no doubt they had both been working at South Kensington Museum. So it went on; the designer was as fond of working in these particular styles as the manufacturer, and bringing things which he said were in vogue. He did not like to hear the manufacturer run down as a man who thought solely of himself; he felt, or ought to feel, and he believed most of them did, that they had workmen, with their wives and families dependent on them, and in order to keep them employed they often had to produce things which they might not think to be in the best style of art. One man of good taste would say a thing was very good, another of equally good taste would say it was bad, and a third would not look at it at all; and they often had to go by the public taste. He did not much care for co-operation, and did not think it would be of much service.

Mr. W. SCOTT-MORTON said twenty-five years ago, having gone through the work of student at a schoo of art, he thought he would strike out on his own account, and try to sell designs. He began with book covers, and going down Fleet-street one day he sold a design for 15s., which

gave him a little encouragement. He then tried wall-papers, but was told on all hands that those things would not sell, and he had to find out what would. He resolved to put in something which would tickle the public, yet draw them on; and he might say that that was not a bad policy, and it would be a good thing if other designers would do the same. There were many of them no doubt very conceited, as he was himself. Only a few weeks ago an artist connected with the guild of which he was a member showed him some designs, which he said he could not get the public to take up, but he thought, by-and-bye, he should get them up to it. The public, however, were great educators, and had a broad common sense which the artist ought to appreciate. A man might work in a corner all his days and make no impression, although he might think he was doing splendid work. Unless he got hold of the public and affected them, it was impossible for him to make a mark, or lead the public on to better things. There was a very good opening at the present time for those who had real ability. Trade was developing into two distinct branches—first, sales of large warehousemen who lived by advertising—but the appreciative public were so sickened by that line of business that they were going more after specialists, and there were now more favourable opportunities for real artists than ever, and the opportunities were sure to grow. No doubt the wide dissemination of art teaching was educating the public, but he felt very strongly what Mr. Warner had said, that the manufacturer had his place. Mr. Warner, himself, had infused a great element of art into his work, and the manufacturer had a power in educating the public which an artist had not. There were the expensive processes which the mere craftsman could not manage, and for which the capitalist must arrange for being carried on. He did not believe in co-operation, although he had a strong feeling on that, and had at one time tried it. After sojourning in Italy he had a strong desire to give himself to artistic work, in which his own hand would do all that was necessary, but he saw the necessity of keeping up a connection with his workmen—as there was a very healthful tone in associating with a great number of artificers in every-day life—and so he resolved to start a co-operative scheme, but although he did his best it failed. At the present time they were effected greatly by circumstances which their forefathers had no experience of; the world opened up so much, and there was such a demand for talent, that you might have a very good workman to-day, and to-morrow he might have better terms from America or somewhere else, and off he went. He had in his mind two large firms working in the same line, one of which employed over one hundred designers, while the other was not so extensive, but the founder having been an artist, gave a specialty to the work. Within the last few months the smaller firm had been deprived of some of its best assistants, who had been drawn away to America. In the other case, the establishment was so large, and the capital so considerable, that the men were retained by giving them higher prices; but it was only in a very large concern that such a thing could be done.

Mr. Day, in replying, said he had not attempted more than to state the mere outside of the question; perhaps he had rather exaggerated it in the hopes of getting discussion. He entirely agreed with Mr. Warner, and others, that there were manufacturers who devoted themselves to their work with as much enthusiasm as an artist, but he could not allow that this was a general thing. As a rule he did not think men carried on business with any other idea than that of making profit. He had been told so over and over again, and as a rule manufacturers had no scruples about acknowledging it. He simply threw out the idea about co-operation, which might have something in it. With regard to the Chairman's remarks about the publishers and dealers taking the place of the patron, there might be something in that, but he did not think the publishers or dealers were such great benefactors. The first publisher he tried to have dealings with was one of the largest in England, and he sent him a little thing he had produced entirely at his own expense, and which was necessary for him to sell in the course of two or three days, or it would be useless. He said he would not mind selling on certain conditions, which were to take them on sale or return—return them dirty or ragged—and that he should have 10 per cent. off the usual trade price. That did not seem to be the sort of dealing which was of much benefit to him. It was simply taking advantage of his position as a capitalist. There was a gentleman in the room who told him not long ago he was anxious to publish a work of art. The publisher had nothing to do but to put it before the public, and his terms were that he should take no risk—in fact, there was none—and the thing was to cost two guineas, out of which the artist was to receive ten shillings. That did not seem to him to be encouraging art. No doubt they would make less if there were not so many dealers, but probably it would be a benefit to the artist; certainly, it would be an advantage to art.

The Chairman proposed a vote of thanks to Mr. Day, which was carried unanimously.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 25, 1888; B. W. Richardson, M.A., M.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Campbell, Lieut.-Colonel Sir Archibald C., Bart., M.P., Blythswood-house, Renfrew, and 2, Seamore-place, Mayfair, W.

Chubb, Sir George Hayter, 128, Queen Victoria-street, E.C.

Clayton, Lemuel, Wellington Mills, Halifax.

Faulkner, Frank, Crosswell's Brewery, Oldbury, and 3, Furnival's-inn, E.C.

Manchester, The Lord Bishop of, D.D., Bishop's-court, Manchester.

Simpson, James, 8A, Rumford-place, Liverpool.

Smith, Alfred, Excelsior Chemical Works, Clayton, near Manchester.

Stanton, Edward Wollaston, M.A., 5, Verulam-buildings, Gray's-inn, W.C.

Taylor, Richard Strange, 83, Shardeloes-road, New-cross, S.E.

Watt, Hugh, M.P., 107, St. George's-square, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Bailey, George, 55, Gray-street, Blackfriars-road, S.E.

Beard, Edwin Thomas, Colonial College, Hollesley-bay, Suffolk.

Billing, Rev. Fred. A., LL.D., 7, St. Donatt's-road, Lewisham High-road, New Cross, S.E.

Bond, Robert Beaumont, Old Bank-house, Ipswich.

Boston, Henry George, Piccadilly, York.

Francis, William Henry, 5, Coleman-street, E.C.

Holme, George, Derwent-house, Milford, near Derby.

Hughes, Thomas, 44, Piccadilly, W.

Husni Bey, Lieutenant, The Gun Carriage Department, Royal Arsenal, Constantinople.

Joyce, Samuel, jun., 113, Richmond-road, Dalston, E.

Liddon, Rev. Henry Parry, D.D., D.C.L., Canon of St. Paul's, 3, Amen-corner, St. Paul's, E.C., and Christchurch, Oxford.

Sutton, Leonard, The Royal Seed Establishment Reading, Berks.

Woolf, Sidney, 7, King's Bench-walk, Temple, E.C.

The paper read was—

PHYSICAL CULTURE OF WOMEN.

By Miss M. A. Chreiman.

I have sometimes thought that no fact has had, and still has, more difficulty in getting itself understood than the fact that—

A sacred burthen is the life we bear.

As regards the psychical life indeed, the fact is, in some sense, admitted; but the vast preponderance of value which long teaching has attached to what it has called the "real entity," the "kernel and the core of our being," the spiritual and eternal, has only added to the difficulties of estimating the valuable and the valueless, the fictitious and the real, the precarious and the enduring, as determined by the interests of the whole nature of man. Now, although the teaching which separates, with too black a line of demarcation, time and eternity, the moral and the physical, the body and the spirit, may content us in our less thoughtful years, to many of us, I imagine, there comes a time when we can no longer look without bewilderment on the manifold confused, conflicting elements of human life; or witness without painful questionings its weaknesses with its possibilities of strength; its hazy hope with its fatal deficiency of definite purpose; the measureless multiplication of its failures, and the bitter barrenness of so many of its fulfilments; and so doubting and inquiring (at a time when to us possibly life lacks what once it gave, and demands more than it has ingathered), we can but come to feel, I think, that the interests of time and of eternity are co-related; that in all that is most efficient for moral and intellectual well-being, it is impossible truly to say this is of the body and that of the spirit; that nothing can separate the divinity from the humanity in us, for behold, "the kingdom of God is within" us, and in very truth

A sacred burthen is the life we bear.

Pity is it that in the existence of individuals and in the existence of nations, the truth is realised so feebly and so late; realised when a prolonged squandering of vital force has reduced to mediocrity what might have been of the best; and when the processes of error or of "letting be" have induced catastrophe that life's years are too short and its science too limited to redeem.

Complicated, indeed, are the considerations which confront us, when we would raise voice or pen against this cumulative physical waste of generations past, and for a hope sure, and only uncertain because weighted with conditions of effort and of abstinence that our own generation is all too little prepared to take up.

For acknowledging, as we all do, the desirability, nay more, the necessity and bounden duty of relieving suffering and of saving endangered life, we have strangely little sense

of responsibility in respect of the prevention of suffering and the quality and duration of life; comparatively few of us, indeed, have come to recognise the extent of our power in the matter, and, passing strange — strange as belief in crucible, alembic, and elixir, by which visionary and philosopher, in past days of insanitation and ignorance, met their age's natural and worthy desire of prolonging life—are the objections which men and women now, late in this nineteenth century, urge against the efforts of those who, with intelligent conception of process, would convict of individual responsibility in respect of perfectibility of organisation, increase of vital capacity, and degree of vigour, activity and endurance of mental and physical powers.

Amongst these objections it is incredible how potent for obstruction are the beliefs that "what is to be will be," that pain is a beneficent agent of spiritual uplifting, that early death, if not a special mark of divine favour (as we used to hear), is a mysterious dispensation of divine providence, and that were it not for worry, disappointment, and distress, we should be bound by flowery bands to earth, too long or too intimately for the interests of a "higher life." Often, and very earnestly, when in contact with induced pain and dejection, or with their visible and eloquent but unseen and unheard premonitions, have I longed for a sense of physical religion in those with whom I have to do, and realised (or thought I realised) what a power for energising and elevating soul and body would be a general teaching from pulpit, as well as from platform and from pen, of the truths that the functions of pain and of affliction are not necessarily sanctifying and purifying, and the comfort our age needs is the comfort that exhilarates as much as the comfort that resigns; that shame, and not glory, should be the religious accompaniment of our preventible tribulations; that life, like every other blessing, derives its value from its use alone, and this being so, such symmetry and beauty as are evidence of organic soundness and perfection of function are the birthright of every one and the charge of all; that contentment with needless misery and conditions which induce disease is an immoral contentment; that the great books of nature and of life are as truly books of revelation as is the "written word," and that it is by neglect of their pages that we miss the countless happy impressions that might give full exercise to our every capacity, and encompass us with influences in all powerful combination for our physical safety and our spiritual rest; that life is never bounded by the cradle and the grave, for men and woman live not in themselves alone; that the commonly accepted divorce between the religious and the secular, that excludes so many of life's most needed lessons from its place of holiest and most influential instruction, is not of the Teacher of whom Christians profess to learn, the secularness of whose divine teaching touched "the world at all points, and the energy of whose compassion met every misery of the body with instructive alleviation, [from which we ought surely to have learned long since that all that promotes health and happiness ought to promote virtue, and that the obligation is one which Christian morality is called upon to enforce, for "certain is it that the highest possibilities even of moral culture in the race lie not in supernatural regeneration alone, but rather in the organised constitutional uplifting of the elements within humanity upon which grace works, and out of which it must shape its best specimens of redeemed men."

If, I venture to think, such truths as these came from the many instead of from few pulpits of our land, and became the basis of home and of school teaching and governance, their application by evolved principles would so emphasise the general and special teaching subsequently given, as to provide the now missing basis for energy and truthfulness of physical culture, viz., adequate reasons for physical righteousness, and for earnest steadfastness in developing "the aids to noble life that are within;" and would so revolutionise thought and feeling as to lift the activities of life on to the truer and higher lines of purpose from which alone (in this age of utilitarian achievement for place or diploma taking, for mark making or for money making) can issue—co-operatively and continuously—the formative and corrective effort which physical culture requires.

And surely culture—that is, improvement, advance towards perfection—is what we have a right to ask of the education, the civilisation of our age, for nothing is of greater importance to us, individually or nationally, than the application of this progressive principle to the quality of our girl life, and the discipline by which it is to be adapted to its life work, for certain is it that upon the moral and physical qualities of our women depend mainly the security, order, and happiness of our households, and the physical, intellectual, and moral improvement or deterioration of our race.

Transmission of a sound constitution is the first consideration of physical culture (and for this men and women ought to take care so to circumstance themselves by wise selection of partners in life as to be able to say with Wm. Honeycome, "In short she is such an one as promises me a good heir to my estate, and if, by her means, I cannot leave to my children what are falsely called the gifts of birth, high titles, and alliances, I hope to carry to them the more real and valuable gifts of birth, strong bodies and healthy constitutions), for, says Ribout, 'Heredity extends over all the elements and functions of organism, to its external and internal structure, its grades, its special characteristics and its acquired modifications.'" The law of transmission, entailing as it does for generations the blessing or curse of constitutional strength and purity, or of constitutional weakness and disease, morbid or healthful impulses, acquired habits of virtue or of vice, magnifies into vastest proportions the responsibilities of parentage. Can anything be more cruel than parental transmission of unasked life, weighted with dominant impulses to vice, or with constitutional tendency to agonising disease? And yet such heritage is, in ninety cases out of every hundred, a game of hazard, a lottery of ignorance or of passion, in respect of which no teaching is authoritative, no governance exists, no individual is counted responsible.

No wonder is it that so few of us approach perfection, but wonder it is that, considering how nature works towards restitution of strength and beauty, our educators concern themselves so little with the processes of modification and emancipation by which the victims of baneful hereditary influences may, in greater or less degree, venture to hope. For surely if beauty be the external sign of goodness in organisation and function, it is necessary that instructors, recognising how cardinal a part of their work is the development and restoration of beauty, so cultivate their artistic sense as to be able to recognise its every degree and modification by which physical and moral character is evidenced, and so cultivate their powers of observation of so-called "natural" defects and of the processes of acquirement of induced defects, as to be competent to advance and emphasise nature's remedial work by such corrective direction of physical vital forces as their knowledge of physiological and psychological principles, and their study of the habits, needs, and possibilities of infancy, childhood, and youth may lead them to adopt.

To what extent diseased organs may regain healthfulness, debased tissue be regenerated, and deformity give place to rightness of form; to what extent is possible restoration of lost purity to the spirit, lost power to the intellect, lost grace to the frame—we know not; for that harmonic development of body and mind, that wholeness and fulness of life which we call health, has not yet become the direct care and interest either of the physicians or of the educators of our youth; the fact that health is the natural and only right condition of existence, has as yet no national acceptance, and consequently the truest element of education, the noblest branch of medical science, viz., maintenance of that condition of soundness in which life must be for the wholesome and thorough performance of any and all its duties, has little interest and no standard—its results are unlooked for, unrealised, and unpaid.

How long this will continue to be so must depend upon the voice of the people; we wait for and look for an enlightened public opinion, but certainly "nothing can better deserve the researches of the physiologist, or the exertions of the philanthropist, than the fact that there are laws of which we have as yet only a glimpse, according to which we may influence the amelioration of the human race in a manner the most extensive and profound," and said Cabanis (and many of our wisest teachers have written in the same way):—

> "After having occupied ourselves so curiously with the means of rendering more beautiful and better the race of animals, or of plants that are useful or agreeable — after having remodelled a hundred times that of horses and dogs—after having transplanted, grafted, cultivated in all manners fruits and flowers—how shameful is it to have totally neglected the race of man! As if it affected us less nearly! as if it were more essential to have large and strong oxen than vigorous and healthy men, highly odorous peaches or finely striped tulips, than wise and good citizens!"

After good birth the concern of physical culture is orderly growth, and harmonic maintenance of the physical and mental powers during growth. For this perfect nutrition is necessary, and the chief essentials of this nutrition seem to me to be:—

Good atmospheric conditions (this first, because body and brain being largely composed of oxygen, nitrogen, and carbonic acid), every hour of day and night from birth to death.

Whether we will it or not, we depend upon Nutritive Elements supplied by the atmosphere

—pure, fresh, bright, vital air, then, is health's first support.

Then, Food, simple, and during the period of growth in liberal moderation.

Perfect cleanliness of person and surroundings.

Warmth, without excess of clothing, without pressure of undue weight.

Exercise of the physical and mental faculties by hopeful work and healthful play.

Avoidance of those occupations and excesses which tend to the deterioration of mental or physical power; and Repose, after action, in natural and easy sleep.

The physical treatment of the child during the first years of its life is of immense importance in respect of the quality and duration of its life.

When we consider how greatly its vital powers are taxed for its physical formation and expansion during the first years of growth, it is not difficult to realise this, and the fearful mortality which still prevails amongst children leaves no possibility of doubt but that education has very much to do, and civilisation very much to amend, with regard to this period of existence.

Hufeland says, in a most useful little book translated by Sir Erasmus Wilson, "A child comes into the world as a being only half finished. The most important and delicate expansion, that of the nerves and organs of the soul, the organs of respiration, the muscular system, the teeth, the bones, the organs of speech, and all the other parts, both in regard of form and structure, now follows. One may readily comprehend, therefore, what influence the different circumstances under which this continued process of formation and expansion is carried on, whether they act so as to impede, derange, and weaken, or to accelerate, must have on the perfection and duration of life." And his precepts and rules in respect of this period of life are (shortly) as follows:—

"All the organs, but in particular those on which health and the duration of physical as well as spiritual life chiefly depend, must be completely formed, exercised, and brought to the highest degree of perfection. Among these I reckon the stomach, the lungs, the skin, the heart, the vascular system, and the organs of thought. A foundation may be laid for good lungs by pure open air; and afterward by speaking, singing, and running; for a sound stomach, by wholesome food, easy of digestion, but neither too strong and stimulating nor too highly seasoned; for a sound skin by cleanliness, washing, bathing, pure air, a temperature neither too hot nor too cold, and afterwards by exercise; and for a strong heart and vessels, by all the above means; in particular by wholesome nourishment and by bodily motion.

"The successive expansion of the physical and spiritual powers must be properly supported; and be neither impeded nor too much promoted. Attention must always be paid to an uniform distribution of the vital power; for harmony and equality are the foundation of health and life. Bathing and free air will contribute to this in the beginning, and afterwards bodily exercise.

"Every cause and germ of disease in the body must be removed and banished; such as accumulations of phlegm, obstructions of the mesentery, and sharp acrid humours; as also faults which may arise from external hurts and impressions, too confined bandages, &c., &c.

"The vital power itself must be always sufficiently nourished and strengthened, particularly by means of fresh air; and the healing power of nature must above all things be supported from the beginning, because it is the principal means which lies in ourselves for rendering the causes of disease ineffectual.

"The whole operation of life and vital consumption must not at first be put into too great activity, but be preserved in a moderate state; by which means its tone may be regulated for the whole life, and also for a slow and a long life."

Note, please, in connection with that last paragraph, a statement which he makes in another part of his book. He says that the enemies of our life have in modern times dreadfully increased, and that the degree of civilisation, luxury, refinement, and deviation from nature in which we at present live, by too highly exalting our life, tends to shorten in the same proportion our existence; and that by these means internal consumption is from birth so accelerated, the physical life of the child so early intensified, its organs rendered so weak, tender, and sensitive, that "one may assert that, through two years' treatment of this kind, an innate vital capacity of sixty years may be reduced one-half, without reckoning those evil accidents and diseases which may besides be the consequence. As one of the most remarkable cases of prematurity, he instances that of Louis II., King of Hungary, who was born so long before the time that he had no skin. In his second year he was crowned; in his tenth he succeeded; in his fourteenth he had a complete beard; in his fifteenth he married; in his eighteenth he had grey hair; and in his twentieth he died.

"In the education which is bestowed on the young in the next stage of life—I mean, on those who are

passing from the eleventh to the sixteenth or seventeenth years of life—the errors committed in respect to health are often as pronounced as in the earlier stage.

"This period of life is in many respects extremely critical, the rapid growth of the organs of the body, the still imperfected condition of the most vital organs; the quick changing and yet steadily developing form of mind, which, like the handwriting, is now being constructed; the imitative tendency of the mind; and, not to name other peculiarities, the intensity of feeling in the way of likes and hates;—all these conditions, physical and mental, make this stage of a human career singularly liable to disorders of a functional or even of an organic kind. For one organ of the body, or for one propensity of the mind to outgrow or outdevelop another or others, is the easiest of all accidents in this stage of life, unless care be taken to preserve a correct balance." *

"It is with this critical period, and his or her conduct during it, that all that youth deems most valuable; all that can decide fortune and happiness in the world; stature, figure, strength, voice, health, and mental powers, are most intimately connected."†

I have quoted these passages, because I am most fully convinced that all the items therein mentioned are largely the business of the physical educationist—of course, conjointly with parents.

My own method of examination of the physical capacities and requirements of all members of my classes, &c., who are brought to me for such examination, is as follows:—

I will give you, first, my heads of observation and inquiry; then, some of my reasons for such observation and inquiry.

The heads of observation are:—Age, height, weight, circumference of head, vital capacity of chest. Force exerted by hand-pressure—right and left—noting difference between the two. Power of muscles of back, &c., power of muscles of arms, chest, &c. Sight, hearing, voice, smell; condition of the muscular and osseous systems, and customary physical deportment.

In respect to pupils sent to us by their medical advisers for remedial exercises, &c., and in the case of those who, in course of examination, we find to be in need of, and not receiving medical attention—to which need we direct the parents by written statement on our examination forms—we further make observation of such of the conditions following, as, in our opinion, call for notice:—

Aptitude for sleep, Capability for muscular exertion, Capability for mental work, Co-ordination of movements. If action of heart be normal. If action of skin be normal. Temperature at night. Tendency to disease. Tendency to asymmetry.

These observations are carefully recorded, and form the basis of our instruction and assistance in the respective cases.

Member of............Class.
Date....................188
Day of Week..............
Age...........Years.............Months.
Height in Stockings.........Feet.........Inches.
Weight—Indoor Clothing, Stockings........Stone ....lbs.
Circumference of Head........Inches.
Breathing Power—by Expiration. ......Hours after Meal. Posture, Standing. } .... Cubic Inches.
Strength—by Hand Pressure,
Right Hand.......lbs........Left Hand.
Lifting Power........lbs.
Pull in Front of Chest (Antagonistics)........lbs.
Length of Sight,
....Type at a distance of.........Inches.
Right Eye........Left Eye........
....Wall Type at a distance of....Feet.
Right Eye........Left Eye........
Colour sense ....
Customary "home" carriage ....
Remarks ....
Any known or suspected weakness or disease of heart or spine must be mentioned before entry of pupil.

Observations of one or more of the conditions below mentioned are made on behalf of pupils entered for our remedial practices, or otherwise under (or in our judgment requiring) medical attention—

Muscular condition of spine.
Muscular condition of feet.
Action of heart.
Sight—short, astigmatic, &c.
Hearing.
Voice—pronunciation, snoring, &c.
Sense of smell.
Sense of taste.
Skin.
Sensation of temperature at night.
Sleep.
Co-ordination of movements.
Capability for muscular exertion.
Capability for mental work.
Tendency to disease.
Tendency to asymmetry.
Improvement to be expected in the constitution before adult life.

In respect of the first three records—viz,, age, height, and weight—the practical importance, as indicative of the healthful

* "Ministry of Health," by Dr. B. W. Richardson.
† Alex. Walker.

development of the growing child, is at once evident. Progressive loss of weight during growth (although sometimes an evidence of increasing health) is usually a sign of impaired nutrition, calling for anxious attention to the morbid waste. Abnormal increase of weight (this chiefly after cessation of growth, and if in connection with other symptoms of loss of health) is also a sign of impairment of nutritive power, and is not seldom indicative of tendency to degeneration of tissue which may lead to cardiac, renal, or cerebral mischief.

Should arrest of growth or loss of weight occur, its detection in time to bring the pupil under medical notice for early removal of the cause of obstruction is the duty of its parents and educators, and for this rate of growth should be regularly observed.

Mr. Charles Roberts and Mr. Francis Galton have given valuable imformation in regard to normal height and weight, the typical laws of proportion, &c., in their respective works.

Osseous and nerve-muscular signs of brain condition are of great importance in the prosecution of the work of physical culture, height and circumference of head, facial expression, character of movements, quality of vision, hearing, &c., capability for mental and physical exertion, aptitude for sleep, &c.—all come, more or less completely, under this heading; for (notwithstanding the teaching of the ancient authors, who located gaiety in the spleen, wisdom in the heart, anger in the gall, love in the liver, and vanity in the lungs) we know the brain to be the source of sensibility and motion, the dominant organ of control of the physical functions of respiration, circulation, and nutrition, and of the mental functions of imagination, reason, memory, &c. All possible direction of its tendencies of structure, and detection of earliest sign of functional derangement, ought to be the business of parents and educators, who should have enough knowledge of the marvellous delicacy and intricacy of brain structure to fear disturbance of the physical functions of its cells, and interference with their progress and their multiplication from the simple division of earliest life to the twelve hundred millions of adult life; should remember that brain culture consists in "the perfecting of the apparatus for mental acquisition, and for mental expenditure;" and that watchful care (if it lack not knowledge) may do much towards that noble balance of structure and of function, of which physical activity, good health, and good temper are earnest and evidence.

In all our measurements, it is not so much a fixed rate of growth, nor a fixed standard of size that we regard; although approximation to the normal standard is desirable, and any serious departure from it is subject of inquiry—as it is, uniform progress in growth, and symmetry of relation between all parts of the growing body; but it is obvious that if the bony case of the brain suffer arrest of growth by too early union of its parts and consolidation of its tissue, brain expansion is prevented, and in corresponding degree intellectual power is lost. Men and women of great capability have had, as a rule, large heads associated with large chests and powerful lungs; but abnormal size may be indicative of hydrocephalus, or other disease.

I have only time now to speak of the commonest forms of brain disturbance, which come (or should come) under the notice of the physical educator, viz., headache, sleeplessness, and impaired sight.

When children and girls are first brought to me, I am not seldom greatly troubled by relation of their liability to headache, sleeplessness, or disturbed sleep. I remember reading in the *Medical Times*, that headaches used to be almost unknown in this country, except as premonitory of acute hydrocephalus, or as symptomatic of organic disease of the brain; and that the headaches now so common betoken an irritated condition of the cerebrum and its membranes, as shown by the fact that they occasionally advance into tubercular meningitis; that the head-achy child is only too likely to grow up into the dissolute or insane man, or the hysterical woman; and that grimacings, startings, and pathological movements of one kind and another are (in consequence of irritation of the nerve centres) prevalent amongst children of the more affluent classes, and particularly amongst girls, to an extent that could not be surmised by those who had not made observation on the subject, and that is ominous of disaster.

Sleep—repose after action—is a demand of nature that must be satisfied if healthful balance is to be maintained.

Capacity for eight or nine hours of restful sleep, commenced at an early hour, all our growing girls ought to possess; and the apathy or ignorance which permits the imposition of burdens of labour or of fashion which destroy this natural aptitude, seems to

me almost a criminal matter. At best, wakefulness in youth means insomnia, with its direful train of evils in advanced life, and shamefully often it means break-down of finest physique, ruin of the brightest intellect, at some early and critical stage of life.

In respect of sight, we merely test power of vision of each eye, and note if any deformity or morbid affection of the eyes exists. Every one knows how greatly minor visual impairments, as well as graver cases of loss of vision, are on the increase, and I consider that one most important part of my work is the detection of errors of refraction, in order that parents may be warned against overstrain; against defective, over-strong, or unshaded artificial light; against errors of position; books of bad type; reading with jerky motions of book—as in railway carriage, &c.; and in order that skilled advice be obtained in time to prevent increased or permanent deterioration of the nerve-muscular mechanism of the eyes.

In more than one case children who had, previously to examination, been constantly in disgrace, at school or at home, for supposed inattention and stupidity, have left my rooms to obtain advice and suitable glasses; on wearing which glasses for the detected abnormal deviation—too long or too short sight, astigmatism, or some allied trouble—the children have become as intelligent and as attentive as their companions. One gentleman of my acquaintance was frequently punished, when a boy, not only for not knowing, but for supposed obstinacy in being unwilling to know, what was upon the blackboard. The smart of the cane produced tears, which supplied accommodative media for the abnormal structure of the eyes, and the recovery of sight under the discipline of the cane carried conviction to the teacher of the wilful obstinacy of the poor boy.

We ought to have none of these errors to lament. Alas! that education should ever "take from the morn of life its natural blessedness."

Vital capacity of the chest is an item of examination which is to us of cardinal interest, and for two reasons—the first, that the work of physical culture depends so largely upon it; the second, that we can do so much to improve it.

We observe, chiefly, general form of thorax and abdomen, shape of sternum, ribs and connecting cartilages, and note any bilateral deviation in size and form, unnatural flatness, prominence, or other asymmetry. We also observe the mechanical movements of chest and abdomen during natural inspiration and expiration, and cautiously test these movements during voluntary respiration.

Girls have, as a rule, inferior breathing power; many, perhaps, have never thoroughly inflated their lungs since they were infants; and this is often cause and consequence of serious lack of development of the cavities of the thorax and abdomen, and impairment of function of the viscera contained in them. When the thorax is narrow and flat, the lungs do not expand, their apices are brought too near together, and otherwise they are cramped, and the consequence is, low vital activity of these organs. When bones of ribs are deformed or soft, and action of diaphragm, intercostal muscles, and muscles of abdomen feeble, inspiration must be performed badly. The degree of defectiveness can be considerably lessened in all cases with which we have to do, and in very many, perseverance and care will establish advance so considerable as to add greatly to the value of life, by energising and strengthening all its powers, by neutralising its morbid tendencies, and by creating a reserve of force with which to encounter its hazards.

I am told that with insurance companies, vital power—as measured by the manner in which the function of respiration is carried on—is the surest test for acceptance or decline of candidates for insurance.

When girls brought to us for physical examination give evidence of habitual faults of "carriage," we make examination of the "locomotive apparatus"—of the bones which give support and leverage, and should give symmetry to the body; of the action of ligaments, &c., as seen in the articulations, which should give flexibility to the body, and of the muscles which should give grace of motion to the body; and we try to ascertain what is defective, and to what extent improvement may be expected, and further deterioration prevented by physical exercise, bathing, friction, &c.

In addition to the muscles of chest, as before mentioned, the muscles of neck, back, and feet are those which oftenest require special attention.

I wish I had more time for this part of my subject. Distortion is such a serious evil to a woman, and its artificial production in minor but increasing degree, by means of bad position, is wholesale.

That a matter at first so easy of correction should be a constant element of distress in so

many households, is evidence (I fear) of laxity of character as well as laxity of muscle, and the condition is one which imperatively demands reform by instruction, example, comfortable clothing, and adjustable seats, as well as by adapted corrective exercise.

Whenever we succeed in getting physical culture substituted for the mere teaching of exercise, forceful attention to this matter of position and carriage will be amongst its chief and earliest signs.

If our girls are, at present, stronger or weaker than they formerly were, is a question often asked, and a reliable answer would be educative and interesting. But the question with which we have to do is not simply whether our girls are stronger or weaker than they were a decade, or a generation, or a century ago, but is the ratio of their increase of vital power in proportion to the constant growth of demand upon it? Is it equal to the constant advance of intellectual aim, each intellectual success established, only until the next phenomenon of effort breaks its record, and re-stimulates competitive effort? (I am speaking of course of our workers only). Is their advance in physical stamina in proportion to the demand made upon it? This question very closely concerns us all, for upon our truthful decision and right action in this matter, our industrial, educational, and social stability must in large measure depend.

In this matter, the trustship of education is now, more than ever, a trustship of unparalleled responsibility, for the increase of the detrimental to physical well-being must be reckoned with. True, the age is one of abounding facilities, but the very multiplicity of advantages is in some respects detrimental, and our youth of both sexes have to be fitted for responsibilities, in approaching adult life, greater, possibly, than have been the lot of any past generation. The past offers to them a larger accumulation of facts to be mastered, of productions with which they must form acquaintance for rejection or for use; and their horizon of duty, and of happiness or misery, widens and widens, as, year by year, become more complex the forces to be directed, and more profound the problems to be solved.

We know that one law of our being is that every part of our organism is nourished and grows by doing its proper amount of work; the only way to improve the organs of the body is through their functions. Thought and intellectual activity develop the brain; the muscular system is thus influenced by movement, which movement is not only means and evidence of maintenance of life, but is one of the principal means of maintaining or augmenting mental and physical health and vigour. In cases of incipient disease, too, and of convalescence from wasting disease, it has often a direct and powerfully preventitive or restorative effect, accelerating and equalising the circulation, increasing appetite, and giving power to digestion; strengthening, facilitating, and regulating the functions of all the nerves and vessels of the body.

Proportion of mental and physical exercise should be regulated by age, constitutional bias, and by probable future demands upon the individual in the way of occupation.

The mind, like the body, must not only be exercised—for "the mind, like the body, is spoiled by want of use"—but it must be exercised upon worthy subjects.

I sometimes wonder, not whether there is too much brain exercises, but whether there is enough, if mind is not too idle to become "a kingdom" in the time of waiting, of withdrawal from life's activities that comes sooner or later to nearly all of us, and which is borne in agony of impatience by so many. Of pursuit of knowledge, and of hurry and worry in its pursuit, I see that from various reasons (not necessarily those of the teacher) we have much; but have we the reflective receptivity which culture demands, even for mere structure and growth of brain?

As strength of body and mind, gentleness of character and manner, should be the aim in respect to the physical education of our girls, care should be taken that exercise be not too violent in character, and that while all parts of the muscular system are sufficiently exercised, no part or parts assume undue preponderance of work or power. The truest and best results are brought about by moderate persevering efforts, spread over a long period of time.

On moral and physical grounds prize-giving to girls for feats of effort should be most strictly condemned, for in respect of physical culture, "nothing is ever done beautifully that is done in rivalship, or nobly which is done in pride."*

Apparatus may be used or dispensed with. We generally use balls, clubs, rings, ropes, hoops, bar-bells, or dumb bells; but certain series of our exercises are practised without apparatus. All our apparatus is of very light weight.

In some cases, especially in case of girls in large school classes, who from any cause

* Ruskin's "Ethics of the Dust."

whatever withhold energy and decline conscientious and pleasurable execution of movement, resistance movements are necessary. In this and every other respect educators should bear in mind that they have individuals to consider, not merely systems.

I think it is very desirable that children and growing girls should have more systematised play than they get, and that some arrangement by which the removal of roofs of exercise halls could be accomplished, for the uninterrupted admission of air on dry warm days, is very desirable.

Whenever deep, voluntary breathing or singing is practised in connection with active exercise, the utmost caution should be exercised; in all quick movements the breathing is sufficiently accelerated by the movement. I cannot help fearing that not a little harm may be done by use of these exercises by teachers who have but little knowledge of the delicacy of the animal mechanism upon which they work. Some time since, I saw practised with loud singing an exercise which brought violently into play the muscles of respiration, and by the double effort the lungs must have been considerably overworked. It seemed to me that in the case of weak members of the class the work was immediately dangerous, and that in the case of its strongest it was remotely so.

I do not like uttering cautions about the work of others, but I feel that in respect of vocal accompaniment to exercises, and of other "lung gymnastics," I am bound to do so. I know of a clergyman who, after greatly benefiting by the moderate use of respiratory exercise, under the skilful guidance of a scientist in London, so distended the air-cells of the lungs by immoderate practice, after return to his country vicarage, that he will never recover.

Of singing and elocution as essential parts of moral, mental, and physical training, we have no time to speak this evening, but if they were practised as they ought to be, I doubt whether the need for other lung gymnastics would long continue to exist,

Dr. Pritchard wrote, "the idea of beauty of person is synonymous with that of health and perfect organisation," but it should be remembered (as Alexander Walker points out in his *Analysis*) want of beauty in any one of the systems of which the body is composed indicates want of goodness in that system only; for instance, "there may in any individual exist deformity of limbs, and this will assuredly indicate want of goodness in the locomotive system, or that of general motion. There may exist coarseness of skin or paleness of complexion, and either of these will as certainly indicate want of goodness in the vital system, or that of nutrition, whilst malformation of the brain, externally evident, will indicate want of goodness in the mental system or that of thought."

The Greek preference of beauty to every other advantage, its "placement directly after virtue in the order of their affections" was unquestionably philosophical (because, although a fair exterior may conceal much that is unworthy, we are justified in expecting its correspondence with admirable and elevated qualities of character), and it was a result, doubtless, of that interested veracity of observation which led them to scientific conclusions and to a scientific practice, in this matter of physical culture, which in its best days was simple in process, healthful and artistic in result.

Of the noble discipline of their literature we partake in increased and still increasing measure; is it by multiplicity of ignoble books that the mark of noble teaching is so lightly made; that for the rational and worthy discipline of such discourse as that of the Greeks, we substitute conversation so feeble or extravagant, and so commonplace, as is that of thousands of our girls in this age? But conversation, as a part of physico-intellectual training, I can only allude to to-day.

I often hear of my "system." I should like to say that my system consists in effort to get an equal balance of good working organs of the body, "measured gain" in beauty and order and permanence of function, not in teaching any particular set or sets of exercise. That was my reason for speaking of the necessity of ascertaining all one can of the physical requirements of the individual, and of meeting those requirements. Systems! I am amazed at the opulence of hope in a system of exercise, with the mightily prevailing indigence of intelligent principle and fixed purpose of well-being! For surely physical culture should commence in earliest infancy; should recognise all the elements, functions, and organs of our complex being, to train and develop, direct and preserve them to their legitimate purposes; should minister to the advancement of manners, faculties, propensities and affections, and aiding in their preservation from the dominion of appetite, passion, or fashion; should contribute towards the sum of human happiness,

which can only be complete when all powers of mind and body have their full and legitimate scope and exercise. I suppose we are a long way from the time when ugliness, deformity, and disease will be counted penal by our legislators, but I hope we are within measurable distance of the time when society's rights in respect of the goodness of our physical character will receive some protective recognition, for as Dr. Nicholls, in his "Social Life," reminds us, sight has a right to beauty, symmetry, and elegance; taste has a right to gratification by the wholesome and the good, and should be protected from perversion to the unsavoury or injurious; smell has its rights, violation of which is impolite and impolitic; and hearing loves sweet and pleasant sounds, and is pained by discordant, harsh, and unpleasant ones.

In respect of manners—I think the teaching of good manners should be a part of physical culture. "Instinctive," do you say? Well then, let the work of education be to establish, or revive, a higher standard of manners on nobler and broader bases, for as social and political relations become more complex, and our sensibilities more delicate, this seems necessary to prevent frictional distress.

I am sometimes told that my "aim is too high;" that in respect of school teaching I must "get in the thin end of the wedge;" that the necessary sub-division, the necessary dealing with classes in proportion to their physical capabilities and degree of advancement (as in other studies) is impossible; that the loose dress is a difficulty; that physical culture requires more time, more teachers, and more highly-trained teachers, than "drill," and that parents know no difference, and appreciate the one as much as the other.

Well, if this continue to be so, then indeed, we must continue to have "the low level of the majority." Individuals and companies of earnest men and women have worked wonders in respect of improvement in modern school life, even within the last twenty years; but "if education does not go hand-in-hand with health, it is vain to expect that education will bring forth the first-fruits of knowledge, and, what is more important, of wisdom....or produce the mental product that is required for the steady and powerful progress of the nation."*

I think we first require to get into the modern scheme of female education—in the girls themselves, in their teachers, and in their parents—a vital interest, not merely a socio-commercial one; a needs be, a promise of good frnit, for the labour and the play; we want to make them see divine energy in a good digestion, as well as in the impassioned appeal that makes earnest the consciences of men, and understand, as Dr. Richardson teaches, that the "conjugating of a Greek verb is as much a physical process as is the walking on a tight-rope."* Let them know, with him, again, that, "with all the advances and advantages of civilised life, the vitality of the population lies between half and two-thirds lower than it need be;" and let them realise that physical educators—in conjunction with, or under direction of, their medical advisers who know the vital endowment that has descended to them—may, by better mode of cultivating our girls, emancipate them from many of the evils with which life is so needlessly handicapped; and, by ensuring true progress, unlock to them new treasures of life, which shall be to them as the entrance into a magnificent garden, from which they may appropriate and distribute with ever-increasing joy of reception and communication.

Certain initial difficulties have to be overcome, of course; but even the exigencies of school life do not present insuperable obstacles to my mind—if we were hand-bound or tongue-tied by prejudice or fashion, by ignorance or custom, it would be otherwise, but advocates as we are of a new course, claimants for time and for attention from that, and those who already hold established and powerful possession of all the waking hours of our student's days, we, nevertheless, urge our new departure with abounding hope; our principle is powerful, the truth of its basis is undeniable, and the processes and results involved are of the noblest of human interests.

I know from personal experience that the mothers with whom I have to do are with us in our highest aims, so soon as their value is fairly estimated, and even the ignorant mother, in a misty, hazy, altogether indefinite way, hopes great things of her girls.

It is ours to change their passive hope to profitable activity of hope; their ignorance to applied knowledge of powers and special gifts, and of all means of advancing them for individual safety and for social help; and their confusion of regard to such enlightened sympathy with damaged conditions of mind and body as will make further (avoidable) impairment improbable, and amelioration possible and probable.

* Dr. B. W. Richardson, "Ministry of Health."

* Lecture on "Vital Necessities as the Basis of National Education," by Dr. B. W. Richardson.

In respect of "the thin end of the wedge," I should like to know how many generations must come and go before (at our present rate of progress) we can have any occasion to consider the key-stone—"the wedge"—at all. We have quarried our stones, or some of them, and carried them amongst the hurrying crowds; here and there a little building has been done, but of the broad arch of English physical culture, the foundations are not yet laid, its plan is, as yet, unaccepted – nay, it is but partly and imperfectly sketched.

The economic objections to physical culture seem to me as unsound as the religious objections; but, to my mind, there exists one objection, which is very real and formidable—it was in part expressed by Milton, when he said—

"Be not over exquisite
To cast the fashion of uncertain evils,
For grant they be so, while they rest unknown,
What need a man forestall his date of grief;
Or if they be but false alarms of fear,
How bitter is such self delusion!"

But again, I think, with another writer, whose name I forget:—

"If man might know
The ill he must undergo
And shun it so,
Then it were good to know;
But if he undergo it
Tho' he know it,
What boots him know it?"

Our point is—will the results of our increased self-knowledge be preventive of failure, and preservative of power in ourselves, and those of whom we have charge?

It may be that the turning of attention to self, by physical examination, by measurement of powers, and by study of possible meanings of pain, will, in some cases, lead to enervation of character, and, in some degree, be injudicious and injurious, but if this be so, it will be because we have to deal with a long neglect of preventive measures—with disease that has established itself in individuals and families, with morbid complications, instead of natural facts. Progress might have been characterised only by simplicity and safety, but we have to do with reform, and reform is seldom free from some degree of catastrophe. Dr. Playfair tells us 110,000 lives are ruthlessly sacrificed every year, in consequence of the prevailing disobedience to the laws of health, and that 220,000 of our people are needlessly sick all the year round. Surely the accompaniment and train of this wholesale manufacture of disease and death must be remorseful knowledge worse beyond comparison than any effect of practical inquiry, correction, and oversight. I doubt if there is any sorrow much greater than that of watching in some dear one the development of agonising disease that might have been kept latent, or of induced disease that might have been prevented if one "had but known."

We are accustomed to hear civilisation convicted, of enfeebling and destroying nations, we even hear sometimes that our own country has reached that stage of complexity of life, of language, and of manners, at which unity and strength give way, and decadence commences; and those who contradict this only say, "The time is not yet." The time, the period, is the point of difference. The fact "all history teaches," they say.

But I venture to think it by no means certain that such history must be ours, for surely in such there must be failure of advancement somewhere. Is there not something to learn, something to do which we have not yet realised—by what Divine or human law could destruction be the sure and necessary result of true progress? The added refinements of life, its increased capacities of enjoyment, its nineteenth century enlargements of possession and desire—destructive? Yes, indeed, if satiety for ourselves and our own little circle be all we get by them; if they minister only, or mainly, to selfishness, recklessness, or indolence—tend to destruction they do, and must. But in such case surely failure should be charged to lack of counterbalancing advancement in our manners and morals; not to civilisation's bounty in gifts of comfort or of art.

I know that satiety, not less than necessity, enfeebles the body and impoverishes the "spirit;" but satiety seems to me to be as much a barbarism as is the mental and corporeal misery and destitution which, in our dense city population, juxtapose it. There are abounding evidences that the career of our civilisation has not advanced very far as yet. Sense of comfort too sound to tolerate the residence of our neighbours in hovels of dirt and starvation; taste too refined, judgment and sympathy too true to endure the pains and deprivations o our sisters and brothers in the flesh, would but take us back to first and highest principles of morality and manners. Can we not substitute for the satiety which we condemn satisfying provision for the indigence we deplore? "Matter of perpetual adjustment," do you say? True; but by the laborious activities of

such adjustment would be evolved energies and interests that would add strength and beauty to individual character, and be salvation to our national life.

Education destructive? Yes, if we make its site a racecourse of rivalry and exhibition, of chance and excitement, of accident and excess; never, if it be a garden—a field of happy labour, and pure, satisfying, and abundant refreshment for all.

We are told that education has had its victims in all ages—that, in the past, it had its victims to physical excesses; that, in the present, it has its victims mainly to mental excesses.

This, then, is the difference—the unworthy difference—which has made, and may keep, the education present a partner in danger with the education of the past, and curses it with the greater condemnation, because, on the shoulders of the past, from which it has an outlook backwards and forwards, boasting its bravery (as well it may), it rejoices in its blindness, and refuses to see. "What should it see," do you say? Why it should see the the difference that Christianity, and civilisation, and refinement, and spread of knowledge ought to have created — the difference in which would lie advancement, safety, wisdom, and happiness — the facts that education should distinguish between the physical and mental capacities of the sickly, ill-nourished, and in any way pathologically hampered learner, and the strong, well-nourished and healthful one, and so making evident the right limits to mental and bodily exertion should have no altar and no victims, but rather should make men, in all ways, better, by that gradual advance "to lovelier order," within which the rightful and pleasurable exercise of every power and faculty co-operates to maintain the health and strength of the whole system.

We have all heard of intellectual successes which have made men and women paupers in spirit and in purpose. We all know that life's most precious function of sight is being impaired by excessive action, and we have been told by competent authority that "the damage done to the eye may be taken as an index of that which is done to the other organs of the body. We all know that very many of our bright English girls are less well qualified, morally, intellectually, and physically, for wifehood and motherhood, aye, and for helpful and happy spinsterhood, than they ought to be. Yes; education may be destructive, but "the last and worse thing that can be said of a nation is that it has made its young girls sad and weary."* Let us see to it that we educate our girls as highly as possible, but this can only be when we educate in such a manner that physical derangement and degeneracy are no longer possible.

DISCUSSION.

Mr. BROMHEAD regretted that Miss Chreiman had not more practically, by way of illustration, informed the meeting what was doing in other countries in the way of the education of women. Interesting information might be obtained from other lands with regard to the progress of physical education there. He concurred in Miss Chreiman's remark as to the assistance which the clergy might give in this matter. When residing at Southsea some time ago, he was rash enough to hazard a remark at a meeting that, until ministers of religion took up the matter of the physical education of women, and enjoined upon their congregations from the pulpit the moral and religious duty of devoting some portion of their time to that physical end, it would be difficult to enlist the attention of women generally for that object. A clergyman, however, informed him that the clergy had something better to do than to interfere with matters of that kind. The severe castigation he received on that occasion, however, had not altered his opinion. There were, he felt, many clergymen who did not think it unworthy of their office to inculcate in the minds of their congregation the necessity of improving the physical well-being as well as the higher faculties. He should be glad to see opportunities afforded for ladies to meet in airy buildings, free of expense, where they would be sheltered from the weather. In our climate, for six months in the year, ladies at all events could not exercise in the open air, and walking exercise, though extremely beneficial, did not benefit the muscles of the arms and chest.

The CHAIRMAN said he had spoken so often on the subject before them, and in that room, that he was afraid of wearying his audience by repetition. Some of the subjects noticed in the paper, however, called for a word or two. He quite agreed with what Miss Chreiman had said on the subject of the hereditary failures in our nation at the present time. In all his long experience he had never seen a really healthy child. He had said so before, and had been very much criticised for making the statement, but he felt bound to make it again. He did not mean to say that there were not very beautiful children born into this world, and that parents had

* Ruskin's "Ethics of the Dust."

not every right to be proud of their beautiful children, but he meant to say that almost every child born had some traces of disease, which had come to it in the ancestral line, however healthy it might appear to be. It was one of the most solemn matters one had to see to, that these diseases of heredity were, at all events, not transmitted by ourselves to our children, and there was no want of hope in this, because there was no great fear of the transmission of hereditary disease in a wise community. Nothing was wanted but a correct mode of life, in order for the next communities to come into the world healthy. That certainly was what was coming. We could see the hope of it in the great prolongation of life during the present century. Formerly there had been no such prolongation of life, but we were accustomed to see people of the age of 100, or even 105, at which time life went out in such gentle form, that no more pain was felt at death than at birth. Miss Chreiman had spoken of good health being brought about in a diseased generation, and he believed that was quite true. A great deal might be done to counteract those diseases which were transmitted. It was most interesting to see the result of what was being done in that direction at the present time about ten miles from London at the industrial schools at Anerley. He had witnessed there the good health which prevailed, and notwithstanding the children were brought there from every part of London, from parents in the most distressed condition, some of whom had died from the worst diseases, yet those children were being reared into strong, healthy persons. That was a most hopeful experiment, and one extremely gratifying to the English nation. It was a model school and a model system for all countries, and it was one of the first established, as he believed, for the purpose in which the necessary conditions were brought out so fully. He quite agreed with Miss Chreiman with regard to the restoration of organs so as to get a good balance of organs. She had not dwelt too much upon that. People very rarely died from a decadence of the whole body, but rather from the failure of one part of it. One part gave way and all the rest followed. People did not die, usually, from a general failure, or wearing out of all the parts of the body. If we could by our culture establish a correct balance of all our organs we should be doing that which had been ordained to be done in a perfectly natural manner, that is to say, making all parts act together, and then all parts would go to sleep together, the whole of the parts of the body having fulfilled their natural functions. The attempt to producc quick maturity was another most important point. In the present day that subject required to be most forcibly brought out. Quick maturity was not to be desired. Pre-maturity of mind was sought for, and the failure of our educational system in that respect was of a most serious character. Our university system was wrong which insisted that before a child had attained to full maturity it should know as much as not one only, but all the masters who taught it. That system was the most idiotic of all systems of training that were ever conceived or practiced. He gave an instance of a youth supposed by his teacher to be obstinate, who turned out on examination to be only deaf on the side upon which his teacher sat, and a change of position entirely removed his apparent stupidity. In some examinational ordeals any one of the examiners could pluck the rest. The present system was carrying examination beyond all bounds, and the successful men, even when they passed and got their honours, were often failures afterwards in regard to literary ability or talent of any superior kind. Our greatest writers, engineers, and mathematicians sprang into celebrity under far different conditions, and would probably not have risen under the present system. We should not have had our Shakespeares, Faradays, or Grahams, if they had had to pass through this terrible mill of examination. Upon one point he did not agree with Miss Chreiman, when she included in the mental faculties the sentiments as being all a matter of brain, and ran down the old ideas of the Greeks with regard to the location of the functions of the mind. He believed that the old notion was right, that the nervous centres of heart, liver, stomach, and lungs were really the centres of the emotional faculties. Greater attention should be paid to these parts as well as to the development of the brains, through the physical portions of the body. He agreed entirely with Miss Chreiman's remarks with regard to the necessity for sleep in youth to the extent of eight or nine hours. It was really criminal to awaken children late at night to show off their talents, and he had seen little children frightened to an extreme when brought downstairs to sing or talk when only half awake. The period of sleep might be reduced later in life, but with regard to the necessity for an undisturbed good night's sleep for children he could not speak too strongly. On the subject of punishment, Miss Chreiman had touched upon a point of the greatest practical importance. Children were constantly punished for errors which they had not the sense or ability to avoid. Until schoolmasters ascertained that there was perfect ability in the case of every child to see and hear, there should be no punishment inflicted on children, for the punishment was really, after all, upon the children's nature, and for which that nature was alone responsible. He quite agreed with Miss Chreiman in reference to the prize system; it was as bad a system as could possibly be conceived. For youths who had a difficulty in carrying on their studies at college, prizes might be of service, but they should not be given as a matter of rivalry, but simply for good conduct and steady work. Beyond that the prize system was as bad as anything could possibly be. He also agreed with the passage from Mr. Ruskin, that nothing was done well that was done in rivalry or in pride. He certainly thought

those words applied to the prize system. The Greek school was extremely high in attainment, even in physiology and anatomy, and we might say that there are few things in the advanced mental sciences which cannot be found in the Greek writers—in Aristotle, for instance. Credit must be given them for that. Those things required to be better known by the people, for only our scholars knew what the great Greek life was. The more he had thought over that wonderful period in the history of the world, the more he had benefited from the contemplation. In conclusion, he congratulated Miss Chreiman upon her valuable paper, and the extreme elegance of style and manner with which it had been presented to the Society. He proposed a vote of thanks to Miss Chreiman, which was unanimously accorded.

Miss CHREIMAN briefly returned her thanks for the manner with which her paper had been received.

Miscellaneous.

FRENCH PHOSPHATE INDUSTRY.

The *Economiste Français*, writing upon a report by the French Minister of Public Works on the subject of the phosphate beds in France, says that it appears from this report, and the tabular statements that are appended to it, that France is particularly rich in phosphate. The Midi, centre, north and east in particular are well supplied with it, as it has been estimated that the total amount existing in these districts exceeds 32,000,000 tons. The production of natural phosphates rose in 1886 to 184,166 tons, representing a value of nearly 7,080,000 francs (£283,200). It is expected that the production in 1887 will very considerably exceed this amount, on account of the beds recently discovered at Orville and Beauval. The quantity of phosphates dried and ground extracted during the first seven or eight months from the former of these beds was not less than 30,000 tons, from which there appears to be reason to believe that for the whole year the production will not be much less than 50,000 tons. Again, considerable returns are expected from the beds of Beauval, and Hallancourt, and Hardivillers, which were discovered about the same time as those of Orville and Beauval. During the first eleven months of 1886 the exportation of phosphate did not exceed 3,000 tons, while for the corresponding year of 1887 it amounted to 50,732, an increase of 47,615 tons in eleven months. This abnormal development of the export trade in phosphates is, says the *Economiste Français*, due to the impetus given to the new workings mentioned above, which by their wealth and their proximity to the sea, offer exceptional advantages for forwarding their productions to foreign countries. Phosphate of lime has been extracted in eighteen departments—and it is stated that in a very short time workings will be commenced in three or four other departments. The number of quarries amounts to 796, and of workmen to 3,160. In 1886 the most important department, in a mining point of view, was that of the Meuse, from which nearly 52,000 tons of phosphate were obtained, the price of which averaged about 25s. a ton. These phosphates, consumed partly in the neighbouring departments, find their way to Brittany and La Vendée, where they are exposed to the competition of the products of the North of France, and principaliy of the Pas de Calais. In the latter department the production of phosphates, washed and ground, amounted, in 1886, to 30,000 tons, with an average price of about 32s. per ton. After these two departments comes that of Lot, in which the production amounted to 26,000 tons, sold in the Midi at about 25s. per ton, after grinding. The department of the Gard supplied 13,000 tons of triturated phosphate. In the east of France phosphate of lime is obtained from the green sand, principally from chalk in the north, and from calcareous soil in the departments of the Gard, Lot, Aveyron, and Tarn-et-Garonne.

Correspondence.

SCIENCE AND ART DEPARTMENT.

Major-General Donnelly deserves my thanks for so courteously entering into explanations upon various points which I have raised. But will he kindly pardon me for returning upon one or two of the issues? I pointed out that in the provisions of the "Official Directory," amongst the various qualifications of teachers laid down as entitling them to earn grants on the results of examinations passed by their students, "the fact of having learned building-construction in a builder's or architect's office is not recognised as any qualification" in the subject of "Building-construction;" and I challenged Major-General Donnelly to point to such official recognition. His reply is, that the Department has in numerous cases (he does not say of building-construction) "dispensed with examination when the applicant could show that he was possessed of special qualifications." I was perfectly aware of instances in which this was so, and equally aware that this was entirely outside the provisions of the "Official Directory." But why, in the name of common-sense, if the Department wants to have its science classes taught by

men who are possessed of special qualifications, does its "Official Directory" intimate (pages 30 and 31) the possession of any degree of any British or Irish University, or the certificate of having merely passed (at least a "second-class!") a paper examination, and the like, to be the only sort of qualification which it recognises? Is that the way to get such classes taught by men of special knowledge? I repeat that there is not a line in the "Official Directory" to indicate or suggest that the fact of having been properly trained in a builder's or architect's office is recognised by the Department as any qualification at all for teaching the subject of building construction. I observe that Major-General Donnelly observes a judicious silence on the point whether as many as even three per cent. of the teachers earning grants in the various London classes by teaching this subject were ever inside a builder's or architect's office.

Major-General Donnelly thinks that as the examination qualification (second class in the advanced stage in the May examinations) is so low, it ought to be easy for any specialist to qualify himself, by passing it, to be recognised as a teacher. This suggestion illustrates admirably the entire difference between the official point of view and mine. To me, looking at the nature of such a subject as building construction, it would seem that no amount of answering of examination papers is any criterion at all as to whether a man is competent to teach it. The one necessary criterion, beyond general teaching capacity, as I look at the matter, is whether the man has a real working acquaintance with the subject; whether, in fact, he has served a proper apprenticeship to train him in it. The official view, on the contrary, is that any man who can get up any subject (by cram or otherwise) well enough to scrape second-class through the examination is competent to teach it, and if he is only an M.A. of Oxford he is excused even this test! Major-General Donnelly must pardon me for accentuating the difference between the official view and that of a mere individual; but even a mere individual is entitled to hold the opinion that an intelligent carpenter or a trained architect will be a better teacher of building construction than the Admirable Crichtons who are authorised by the Department's rules.

I note that no explanation has even been offered respecting the extraordinary official provision (printed *in italics* on p. 8, Clause xix., of the "Science and Art Directory") which mulcts those students who have earned prizes of that which they have won, if their teacher does not fulfil the arbitrary qualifications officially laid down.

With respect to the clause (No. iii. on p. 8 of the "Official Directory"), which boycotts free education, I note that Major-General Donnelly intimates that I have been misinformed about free schools being prohibited from earning grants. But why did he not add: always provided that in the same town there is *no other school* where fees are charged, for that is the sum and substance of the boycotting clause. Have I put my finger on a sensitive spot, that my use of plain language should have called forth such a strenuous protest? If Major-General Donnelly still doubts my assertion as to the existence of a certain large town in England where, outside the organisation of the Science and Art Department, there exists an extensive local voluntary organisation, carrying out free evening classes (science classes and other), let him make inquiries at Leeds. He will not, I think, find that the subjects taught are restricted to the five-and-twenty specific science subjects that are officially recognised as "science subjects." It is not likely that the teaching would be restricted to South Kensington subjects when, according to Article viii. (p. 3) of the "Official Directory," these teachers are not recognised as entitled to earn grants.

Finally, I note the significant silence with which my remarks about the technical teaching of optics and acoustics have been passed over. May I take it that this silence indicates the near approach of a much-needed reform in the official regulations?

SILVANUS P. THOMPSON.

20, Arundel-gardens,
April 24th.

WHAT STYLE OF ARCHITECTURE SHOULD WE FOLLOW?

Mr. William Simpson, in his reply, has evidently misunderstood my contention "that architecture cannot be compared with painting or sculpture." I was not referring to the æsthetic qualities of the arts, but to the argument which he laid down, that because Turner copied Claude and Vandevelde at first, and afterwards gave up copying and became "Turner," therefore architects should do the same.

In the first place I dispute his premises. Turner never copied Claude or Vandevelde; he may at one time of his life have been influenced by the composition of their works, but he sought always to reproduce the effects of nature. How, then, are architects to follow this example? Painting and sculpture are imitative arts, architecture is creative; the argument adduced from one cannot be applied to the other. Every style of architecture has been founded on its predecessor in a ratio varying according to the number of models existing to be copied, to new and increased requirements, and the progress of constructive science. The less there was to copy the more chance there was for new forms and combinations. We fortunately, or unfortunately, have placed at our disposal now all bygone styles, and of every period, and there is no more chance of our being able to agree together to adopt the principles and forms of any one of these, in the hope of evolving something new, than there would be in endeavouring to agree upon a new language, or a fresh alphabet, or another method of counting. Architecture, in a sense, is a language—the language of our century, and the best that architects can do is to bring its forms into harmony with our

wants and requirements, and to take advantage of new inventions. This is what is done now by architects, to the best of their ability; and the architectural historian of the future will point to the last twenty years in England as productive of a more prolific and original development of style than has ever been evolved in a similar period since the world began, far exceeding that made in literature, painting, or sculpture, and only, perhaps, out-distanced by the progress of science.

R. PHENE SPIERS.

POLLUTION OF AIR AND WATER.

The case referred to by Mr. Manuel in the *Journal*, 20th April, page 633, in which I was concerned, is of such importance to water users (to whom the "Law Reports" are not always accessible), that I would beg to be permitted to give the following extract from a *verbatim* report of Mr. Justice Kay's able judgment in the matter:—

"Given the fact that the amount of pollution brought in by the defendants is such by itself that it would not sufficiently injure this water to make it unfit for bleaching at either of the plaintiff's works, but that the amount they pour in, together with the amount poured in by the father at his works down the stream is enough to produce the condition of things which actually exists, namely, that the water at the plaintiff's works is unfit for bleaching, is the law this, that supposing it is impossible to say that any one of them pours into this stream foul water not enough by itself to create a nuisance, but that what they all put in together does create a nuisance, that you cannot sue anyone of them? If so, I presume a plaintiff who lost that which is his natural right, namely, the right to have the water of the stream pass in its original pure condition, might lose that right entirely by the combined action of a number of manufacturers above him, who might all laugh at him and say 'You cannot sue any one of us, because you cannot prove that what each one of us does would be enough to cause you damage.' All I can say is, in my opinion, that would be a most unjust law if there were such a law.

"If the case were quite new, and my individual opinion had to be given upon it, I should say distinctly that is not the law. A man is not bound to sue anybody until he finds that he is being injured. A riparian owner has a natural right to the use of the water which passes him in the stream in its original pure condition as nature would send it him. If he finds it is no longer in that condition, that it is impossible to use it for domestic purposes or manufacturing purposes, and it becomes a filthy sewer like this stream, and if he finds that was produced by the combined action of the riparian proprietors above him, is he without remedy, because each one of them can say, 'It was not my doing: I only contributed a part, and the part I contributed was not enongh to do you damage?' I put another illustration during the course of the argument which has not been answered to my satisfaction. Suppose there were only two polluting sources, and that one of them sent in a particular chemical which in itself did no kind of harm, and then that the other below him sent in another chemical which in itself would do no harm, but the combined effect of those two chemicals (and the thing is quite possible) would be such that the stream would be poisoned and quite unuseable for any domestic or manufacturing use; would neither of those persons be liable? I have no hesitation in saying that, in my opinion, distinctly, a man so injured has a right to take the several persons who injure him in detail, and to say, 'I am suffering from the combined acts of all of you. If I can prove that each one of you contributes to that result which is damaging me, I have a right to sue, and a right to ask the Court to prevent each of you from sending in his contribution to that which does me damage.' My opinion is, he has that right.

"Therefore, if the case stood so simply, and if I were convinced that the amount sent down by the defendants of injurious matter would not of itself produce actual damage to the plaintiffs, I should hold that they had a right of action against the defendants nevertheless, if it were proved that the deleterious ingredients sent in by the defendants did reach the plaintiffs.

"That is proved beyond question. Everyone of the chemical witnesses admits it might, and I have no doubt that the ferric oxide, being an indestructible ingredient, in the natural course of things would reach the works of the plaintiffs six or seven miles down the stream."

JOHN COLLINS, F.C.S., F.I.C., F.G.S., &c.
Analytical Laboratory,
14 and 15, Bradford-buildings, Bolton-le-Moors,
25th April, 1888.

Obituary.

THOMAS RUSSELL CRAMPTON, M.Inst.C.E. The members of the Society will learn with regret of the death of Mr. Crampton, one of the Vice-Presidents, which occurred at his residence, 19, Ashley-place, Victoria-street, on the 19th inst., after a long illness. Mr. Crampton was born in 1816, at Broadstairs, Kent, and after receiving a liberal education at a private school, was articled to Mr. John Hague, M.Inst.C.E., of London, where he was a fellow pupil with Sir Frederick Bramwell. After serving his pupilage, he was engaged under the elder Brunel for several years, and afterwards with Mr. (now Sir Daniel(Gooch, under whose direction he designed the first locomotive for the Great Western Railway.

He afterwards held a responsible position under Messrs. Rennie, and in 1848 commenced practice on his own account as a civil engineer. Between the years 1842-7 Mr. Crampton perfected the type of locomotive bearing his name, and in which a long boiler, outside cylinders, and a low centre of gravity are the essential and distinguishable features. In 1846, the Gold Isis Medal was presented to him, for "his improvement in the construction of the locomotive steam engine." A locomotive on this principle —the Liverpool—was built, and run on the London and North Western Railway, and was shown in the Great Exhibition of 1851, where it obtained for its designer the grand medal. In that year, 1851, Mr. Crampton succeeded, under exceptionally difficult circumstances, in laying the first successful cable for a submarine telegraph between Dover and Calais. He undertook the whole engineering responsibility in this first practical step in submarine telegraphy, from which has sprung the remarkable developments of this system of intercommunication to be met with all over the world. Mr. Crampton may, therefore, fairly be considered as the father of submarine telegraphy. Mr. Crampton took an active part in the controversy on broad *versus* narrow gauges for railways, known as "the battle of gauges," in which he advocated the narrow gauge. Besides his improved locomotive —which was adopted and has been running on several French railways for nearly 40 years past— Mr. Crampton invented a furnace for burning powdered fuel, revolving furnaces for the manufacture of iron and steel, brick-making machinery, cast iron forts, and tunnel-boring machinery. Mr. Crampton was an officer of the Legion of Honour, and a member of the Order of the Red Eagle of the German Empire. He was elected a member of the Society of Arts on March 17th, 1864. He became a member of the Council in 1882, and was first elected a Vice-President in 1886.

DR. DE CHAUMONT, F.R.S.—Surgeon-Major Francis Stephen Bennet François de Chaumont, M.D., F.R.S., Professor of Military Hygiene at the Army Medical School, Netley, died on the 18th inst. at his residence at Woolston, near Southampton. Dr. de Chaumont was born at Edinburgh in 1833, of which city his father, though a Frenchman by birth, was a resident. Educated chiefly at Edinburgh, he successively obtained the degrees of M.D. and F.R.C.S. Entering the army as Assistant-Surgeon on the 28th of April, 1854, Dr. de Chaumont served with the Rifle Brigade in the Crimean war from the 21st of May, 1855, and was present at the siege and fall of Sebastopol, for which he received the Crimean medal and clasp and the Turkish war medal. He was promoted to the rank of Surgeon on the 20th of June, 1865, and retired on half-pay as Surgeon-Major in 1876. He became assistant in 1863 to Professor Parkes at Netley Hospital as Professor of Hygiene, and on the death of Dr. Parkes was appointed to succeed him, a position which he continued to hold at the time of his death. He edited several editions of Professor Parkes's works, besides writing works himself on sanitary subjects. He was one of the Science Examiners at Cambridge. Dr. de Chaumont had been suffering from heart disease for some months past, and on the morning of his death he had just returned home from Netley Hospital much exhausted. He was elected a member of the Society of Arts on April 23rd, 1878.

General Notes.

HORSEFLESH.—The consumption of horseflesh in France is still large. In the markets of Marseilles, on the average of the last five years, about 2,000 head were slaughtered by the horse butchers and taken for consumption, consisting of 800 horses, 700 mules, and 500 asses.

ARMADA TERCENTENARY COMMEMORATION.—A public meeting will be held at the Mansion-house, under the chairmanship of the Lord Mayor, on 3rd May, to arrange for the celebration of the occasion of the tercentenary of the defeat of the Spanish Armada in 1588. Members of the Society of Arts are specially invited to attend.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

MAY 2.—"Drawing, a means of Education." By T. R. ABLETT. Sir GEORGE BIRDWOOD, M.D., K.C.I.E., C.S.I., in the chair.

MAY 9.—"Locks and Safes." By SAMUEL CHATWOOD. The Lord GRIMTHORPE will preside.

MAY 16.—"Electric Lighting from Central Stations." By R. E. B. CROMPTON. THE ATTORNEY-GENERAL, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 15.—"Emigration." By JAMES RANKIN, M.P.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 8.—"The Decorative use of Colour." By J. D. CRACE. E. C. ROBINS, F.S.A., will preside.

MAY 29.—"Persian Textiles." By CECIL SMITH.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

MAY 4.—"The Injurious Effects of Canal Irriga-

tion on the Health of the Population of the Punjab." By Surgeon-General H. W. BELLEW, C.S.I., C.I.E. Sir JOSEPH FAYRER, K.C.S.I., will preside.

The above dates are liable to alteration.

CANTOR LECTURES.

The Sixth (and concluding) course will be on "Decoration." By G. AITCHISON, A.R.A. Three Lectures.

LECTURE I.—APRIL 30.—Efforts of the Society of Arts to encourage Decoration.—Painting and Sculpture the Highest Form of Decoration.—Definition. — Impediments to External Decoration in London.—Cultivation of Beauty.—Colour.—Want of Decoration in our Public and Private Buildings.—Discouragement.—Value of Old Work.—Eastern Superiority in Colour.

LECTURE II.—MAY 7.—Decoration: the Strict Following of what Nature teaches in adorning her Works.—Delineation of Living Forms: province of Sculptors and Painters.—Colour the Common Province of Architect and Painter.—Employment and Improvement of Present Materials and Manufactures for Decorative Purposes.—Health: as affected by use of Materials External and Internal.—M. C. Garnier's Dream of a Decorated Paris not impossible in London.—Enamelled Pottery.—Use of Opaque Coloured Glass.—Mosaic.—Pietra Dura.—Sgraffito.—Metals for External Use.—Marbles.—Value of Good Workmanship.

LECTURE III. — MAY 14.—Stained Glass.—Enamels.—Woodwork, including Carved, Turned, and Inlaid.—Woven and Felted Fabrics.—Leather: Embossed, Painted, and Lacquered, and Cuir Bouilli.—Imitations of, and Substitutes for, Leather.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. Aitchison, "Decoration." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Miss Ormerod, "Farm Insects."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 4 p.m. Annual Meeting.

TUESDAY, MAY 1 ... Royal Institution, Albemarle-street, W., 1.½ p.m. Annual Meeting. 3 p.m., Mr. W. Gardiner, "The Plant in the War of Nature." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. E. B. Ellington's paper, "The Distribution of Hydraulic Power in London."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. C. M. Woodford, "The Mound-bird of the Solomon Islands." 2. Mr. G. A. Boulenger, "Description of a new Land-Tortoise from South Africa, living in the Society's Gardens." 3. Mr. F. E. Beddard, (i.) "Notes on the Visceral Anatomy of Birds;" (ii.) "The Air-sacs in certain Diving Birds." 4. Mr. Francis Day, "Observations on Fishes of India." (Part I.)

WEDNESDAY, MAY 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. R. Ablett, "Drawing, a Means of Education."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 4½ p.m. Annual Meeting.

Obstetrical, 53, Berners-street, W., 8 p.m.

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

THURSDAY, MAY 3...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. D. Michael, "Researches into the life-histories of *Glyciphagus domesticus* and *G. spinipes*." 2. Mr. C. B. Clarke, "Notes on Root-Pressure." 3. Mr. Arthur W. Watts, "Ovicells of some Lichenoporæ, &c."

Chemical, Burlington-house, 8 p.m. 1. Messrs Horace T. Brown and G. H. Morris, "The Determination of the Molecular Weights of the Carbohydrates." 2. Mr. N. Collie and Dr. Lawson, "The Action of Heat on the Salts of Tetra Methyl Ammonium." 3. Mr. N. Collie, "The Action of Heat on the Salts of Tetra Methyl Phosphonium."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture IV.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Third Report of the Research Committee on Friction. Experiments on the Friction of a Collar Bearing. 2. Mr. Henry R. Towne, "Description of the Emery-Testing Machine." 3. Mr. Thomas Urquhart, "Supplementary Paper on the Use of Petroleum Refuse as Fuel in Locomotive Engines."

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, MAY 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Surgeon-General H. W. Bellew, "The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab."

United Service Inst., Whitehall-yard, 3 p.m. Captain M. Robinson, "Horse Artillery."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. J. K. Laughton, "The Invincible Armada—a Tercentenary Retrospect."

Mechanical Engineers, 25, Great George-street, S.W., 2½ p.m. Reading of Papers and Discussion.

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Prof. M. Trautmann, "General Phonetics."

SATURDAY, MAY 5...School Board Managers (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (With Vocal and Instrumental Illustrations.) (Lecture IV.)

Journal of the Society of Arts.

No. 1,850. Vol. XXXVI.

FRIDAY, MAY 4, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the sixth and concluding course was delivered by G. Aitchison, A.R.A., on "Decoration," on Monday evening, 30th inst.

The lectures will be printed in the *Journal* during the summer recess.

CONFERENCE ON CANALS AND INLAND NAVIGATION.

Committee.—Sir Douglas Galton, K.C.B., F.R.S. (Chairman of the Council), Sir Frederick Bramwell, D.C.L., F.R.S., W. H. Barlow, F.R.S., E. C. Robins, F.S.A., Col. A. C. Hamilton, R.E.

The Conference will commence on Thursday next, May 10, at 2 o'clock, and will continue till 5 o'clock.

On Friday it will be carried on during the same time.

If necessary, it will meet on Saturday, at 11, to conclude the proceedings.

On Thursday, papers will be read and discussed on the following subjects :—

1. History of the rise and progress of canal and inland river navigation in Great Britain and Ireland.

2. Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c.

3. The canals of other countries.

On Friday, papers will be read and discussed on the following subjects :—

4. Present condition of canal navigation in Great Britain and Ireland. Suggestions for its improvement.

5. Canals and railways—their mutual influence on each other.

6. Comparative cost of transport by railways and by canals.

7. The law of canals, and matters relating thereto.

The papers will be printed and distributed at the time of reading. The reader of a paper will be allowed twenty minutes to state the substance of it.

Speakers will be restricted to ten minutes each.

Tickets for the Conference are now ready, and members desiring to distribute these tickets to their friends can obtain them on application to the Secretary. The ordinary Members' tickets will also be available.

Proceedings of the Society.

NINETEENTH ORDINARY MEETING.

Wednesday, May 2, 1888; H. Trueman Wood, M.A., Secretary, in the chair.

The following candidate was proposed for election as a member of the Society :—

Humphrys, Henry Norton, Gas Works, Salisbury.

The following candidates were balloted for and duly elected members of the Society :—

Chatwood, Samuel R., 11, Cross-street, Manchester.
Ince, Surgeon-Major John, M.D., The Mount-house, Farningham, Kent.
Threadgale, Charles, 104, South Circular-road, Portobello, Dublin.
Tomkinson, Michael (Mayor of Kidderminster), Franche-hall, near Kidderminster.

The paper read was—

DRAWING, A MEANS OF EDUCATION.

By T. R. Ablett.

The term drawing, as used in this paper, includes the representation of form, by any process suited to the requirements of schools.

There are several points of view from which the teaching of drawing may be regarded.

1. With some, it is an accomplishment by means of which the glowing landscape, or picturesque ruin, is copied from the radiant chromo-lithograph, and made ready for the hands of the frame-maker, by the united efforts of the pupil and drawing-master. This, by the way, is an unfortunate partnership, and morally indefensible, when the master does most of the work, and the pupil takes all of such credit as is to be had.

2. Others teach it as a method of improving design in manufactures – the South Kensington plan.

3. The Royal Commission on Technical Instruction recommend it to be taught as a necessary element in what is known as technical education.

4. The Royal Academy teaches it as a training for artists.

5. Drawing, taught as a means of education, is a view of the matter which, unlike the others, has received very little attention, and is little understood.

If, in explaining it, my remarks are not always acceptable to those who deal with drawing from the other points of view which I have mentioned, I feel sure that it will be granted that different aims necessitate different methods. My duties have brought me into connection with a multitude of schools, of all grades, for boys and girls, and also with studios, and schools of art, English and foreign. I affirm, without hesitation, that the methods employed for teaching artists and designers quite fail to meet the legitimate requirements of schools.

The kind of training adapted to adults who have special talent for drawing, or urgent necessity for the attainment of skill in its practice, is, on the face of it, not likely to be suited to boys and girls at school, of whom the majority have no special aptitude, and all have little time for practice. Drawing has hitherto been for the few, and the methods of the drawing teachers of the past, and to a great extent of the present, are unsuitable, because they have been developed merely for pupils possessing unusual ability. The intellectual processes are slipped over or slurred, because these pupils possess a sort of intuition that takes the place of conscious or vertebrate thought.

Before stating the advantages of teaching drawing as a means of education, it will be useful to consider how and by whom drawing is found to be helpful. For technical or trade purposes it is constantly used by architects, engineers, military and naval men, advertisers, designers, and numerous others; for purposes of information, education, æsthetic gratification or culture, by geographers, astronomers, scientific men, statisticians, mathematicians, decorators, illustrators, or artists.

Artists may disclaim all connection with education, but scarcely with drawing, although one sometimes hears one artist say of another "he cannot draw." Many artists can profess to know little of the use to which drawing is put by a number of the workers already mentioned, still, as a matter of general education, something should be taught of these various modifications of the art.

The late Right Hon. W. E. Forster once said to me about drawing:—"I tried at school, but I, and most certainly my master, had to give up the hope of my being taught." What was the kind of drawing which Mr. Forster tried to learn? Probably the aforesaid accomplishment.

Is it not a reproach to art teaching that its methods have been so unintelligible, or wanting in their demand on intellectual effort, that a man of such distinction should have been able to make this confession? Is it not a reproach that at the present day, in many schools, drawing should be classed with dancing, and that there is an unspoken feeling in the community that the study of drawing is vague and unsatisfactory, and not to be classed with the purely intellectual, or absolutely necessary, studies? Only last year the head master of a large grammar school, which I examined for the first time, said, in reply to one of my suggestions, "He could not permit progress in drawing to affect a boy's chance of promotion from one Form to another."

Two things are necessary to raise drawing to a position of dignity in schools.

First, we must show that it may be made one of the bases of education, and one that all modern society owes to its children, whatever their avocation or their destiny.

Secondly, it must be demonstrated that it can be taught by collective or class methods as easily as reading, arithmetic, or any other school subject.

The educational advantages of teaching drawing are these:—

A. Educational drawing is valuable as a discipline for training and calling forth certain powers and faculties of the mind which can be developed, to their full extent, by it alone.

The advantages arising from its practice may be summarised as follows:—

1. *Perception of æsthetic influences is quickened.*—Beauty is its own excuse for existing, and as the outcome of æsthetic powers or faculties it is absolute good.

2. *Accuracy in observing and thinking is promoted.*—Drawing has to do with form and certain realities of the material world which it expresses.

All the facts representing the form, dimensions, and natural or mechanical structure of an object can be given by means of drawing, for it is a mode of expression which is unequalled in its power of conveying or of fixing an accurate idea of an object. For this purpose it ranks next to the object itself.

The observation is cultivated because, in certain branches of drawing, every minute particular of an object must be carefully noted.

We are all apt to be deluded by our eyes. Unless the mind can deduce facts from their appearance, its impressions may be altogether wrong.

3. *The graphic memory is improved.*—Memory drawing obliges the observer to look at an object or form carefully and intelligently in order that the mind may retain the impressions gained as so much stored-up observation. The memory is brought into play in every act of drawing. Many artists can remember easily, because they have learned which are the salient points or features necessary for pictoric effect; and the best observers, outside the faculty, are those who have learned to fix in their minds the distinguishing or characteristic forms of faces, or places, and manifold other shapes of which it is useful to retain an accurate impression.

4. *The imagination is exercised.*—The mind must form a mental picture in connection with dictated drawing, also in designing working drawings of buildings, machinery, &c., but especially in composition connected with decorative or pictorial drawing.

5. *Free scope is afforded to the creative or inventive powers.*—Drawing transcends either written or spoken language in supplying adequate means for making inventive thought manifest. By its aid a perfectly accurate idea of any object, which exists only in the brain of the designer or inventor, may be given.

6. *It combines training of the mind, the eye, and the hand.*—It is beginning to be understood that freedom of mind is to some extent dependent on freedom of body, that mental control is connected with physical control, and habit of mind with habit of body. If the senses and the muscles are led to form good habits, these will certainly react for good on the mind.

7. *The powers of description are increased.*—The employment of precise language and nomenclature is to some extent necessitated by dictated drawing.

Drawing is a universal language. Not only is it a means of communication for those who speak the same language, but for all the civilised world. In its geometrical form it is written and read by inventors, engineers, architects, decorators, typographers, and others too numerous to mention. Through its power of representing the phenomena of nature, as they appear to the eye, it appeals in the most direct way to every human being. It enables the artist-poet to stir the emotions of all those who can appreciate beauty in form, sentiment and poetic feeling, whatever be their nationality.

Those who aspire to take a leading or even active part in the doings of this and the next generation must not calculate too much on the requirements of the past, since the world's drama is being played on conditions which rapidly change. They will need the fullest development of the resources of the body, the senses, and the mind. Without practice in drawing this complete efficiency cannot be attained. Educationalists are beginning to find the curriculum of schools somewhat overladen, and already recognise that the various pursuits, instead of being several and independent, are mutually helpful. It becomes apparent that they are interwoven one with another, and may be taught in their relationships. When this is fully realised in practice, there will be less crowding instead of more crowding, and where there is antagonism we may hope for harmony. This movement may be assisted by showing how drawing can be interlaced with other of the school subjects, which are already recognised as essential.

B. Educational drawing facilitates the acquirement of other subjects.—Practice in drawing helps the acquirement of spelling, it is most useful as a means of impressing some of the facts of arithmetic, geography, history, and science, and writing is learned most expeditiously if coupled with it. Drawing is one of the very best methods of training the mind at an early age, and some of its definitions are admirably adapted to the capacity of the young.

English spelling demands a power of re-

membering the look of words, since their sound is not always a trustworthy guide. Everybody has probably written down a word to see if it looked right. The improvement of the *graphic memory* adds to the capacity for learning to spell.

The arithmetic of space is taught by drawing, as the arithmetic of numbers is by figuring. Why should every child learn one and not the other? The arithmetic of space may be taught as soon as a child can use a ruler, and can understand something of drawing to scale. At first, it may well consist of drawing to scale, with the aid of a ruler, the common objects in a class-room—such as the outlines of a door, a window, a blackboard, an easel-stand, the walls, and the floor. It may be used to illustrate the methods of numeration. It is essential to the proper appreciation of the nature of a map. Fractions are made clear by its employment.

Again, the arithmetic of space may be used in learning many facts connected with geography, history, science, and other subjects. Facts, which in figures make no appeal to the mind, can be readily grasped by means of drawings, especially when they are made by the pupils themselves. When a child has to represent facts by means of drawings, it at once becomes plain to it that accuracy is of the first importance, and the difficulties of the drawing teacher are diminished to the extent to which this knowledge is acted upon afterwards in the mere copying of shapes.

The connection between writing and drawing needs no demonstration, although something has yet to be done to bring the fact into practical recognition. Why that worst of drawing tools, the pen, should be put into the hands of very young children it is difficult to understand. We surely ought not to cramp the little fingers at the onset.

A child may be taught to draw before it is possible or desirable that it should learn to write. The formation of the script letters is a difficult and tedious piece of drawing; still everyone can learn to write, and therefore everyone can learn to draw, at least in a way advantageous to themselves.

So difficult is the drawing required in writing, that it is well to prepare for it by encouraging, as a preliminary step, the spontaneous efforts of early childhood, and the development of the senses of sight and touch. These senses must be carefully trained when they are most active—that is in childhood—or they will scarcely develop at all. The colour blindness of an adult, usually incurable, has arisen in very many cases from the absence, at an early age, of the proper training of the perception of colour, and clumsiness with the hands is attributable to similar want of culture. The sense of sight may be trained to some extent by the judicious choice of a child's playthings. Building bricks, which form a constant source of entertainment, may be cut in lengths of 1, 2, 3, 4 inches, and so on; they may also be coloured. It is well to add coloured spheres, cubes, cones, cylinders, and pyramids to the set. Differences in length, colour, and shape will be noted in making selections for building purposes, and the distinguishing names will be learned incidentally, especially if the leader of the game calls for definite lengths, colours, or shapes. Only those who have undertaken to build in order to amuse children can appreciate the delicacy of manipulation that is often required.

A child's fondness for imitating produces in it a desire to make representations of things, which are attractive or astonishing, long before its mind is sufficiently developed to enable it to cope seriously with reading, writing, arithmetic, and kindred subjects. This desire to draw should be fostered and encouraged. Fond parents are too apt to imagine that these aspirations to draw, common to all, are the manifestations of great artistic genius. These efforts should be directed into channels which will greatly help forward an infant's education, but they are often left to die away, because there is a presumption that the child possesses an exuberance of ability in this direction, and that its time will be more profitably spent in some other way.

Children are by nature diligent students, and drawing furnishes the most delightful mode of describing the things which interest them. We can assist the development of a child's powers, by encouraging it to follow up its ideas, and by putting into its hands those materials which will most readily enable it to carry out its intentions. Whether it follows any definite and logical plan, which someone has developed for it out of his or her inner consciousness, or whether it produces good drawings, is of little consequence so long as the faculties get scope for evolution and growth.

From a set of drawings, executed in this way by a boy between 3½ and 7, much may be learned. Most of the drawings were made from the recollection of striking things. A

locomotive engine and train has been drawn many times. One can trace a gradual growth in the complexity of the drawings, which is coincident with opportunities for observing the objects and their details.

The following is a list of some of the things drawn:—Steamer at sea; Greenwich Pier; a lifting crane; a train; designs cut out in paper, and coloured; a lighthouse; viaduct; volcano; church; Beachy Head, with Signal Station; balloon; railway bridge over a river, with train; pier, steamer, and rainbow; plan of Hastings; design for a house; shooting star; stained glass window; Metropolitan and District Railways; maps; aquarium and menagerie combined; plan of railway; plan of a farm; Barnes Bridge during the Oxford and Cambridge Boat-race; and an angel flying down to a ship. Of animals—a horse, cat, dog, cow—birds, and fishes have been attempted; a man, drawn from life; and a caricature of a man frightening a cat away.

The tedious methods of teaching writing, at present universally adopted, are terribly wasteful of the precious hours of school-life. The pupils feel little or no interest in what is simply a dreary discipline of copying lines. The time usually spent in learning to write amounts to something like $1\frac{1}{2}$ years of school-life. Yet experience shows that it is quite possible to greatly reduce this time, by making the practice of the curves of the letters as charming to a child as its own spontaneous efforts to make pictures.

In such spontaneous efforts in outline-drawing, the very young use the method of making a line which is employed in writing. Each separate idea, or perception of form, is represented by one effort of the hand. In drawing a man, for instance, a circle is swept in for the head, an ellipse for the body, and a straight line for each arm and leg. The finished artist sketches on a similar plan, for each stroke is the record of one observation. Although there is good reason for the child's own method, yet we ignore it, and teach elementary drawing by a method of making a line which is quite different to that employed in writing.

The definitions employed in geometrical drawing may be taught quite early, as they do not present the same obstacles to the learner as those of most of the other subjects. For example, the definitions of grammar are subject to many exceptions, and it is extremely difficult to represent them as drawings which will appeal to the eye. They are mere abstractions of the mind, hard to understand and apply. The reverse is true of many of the definitions employed in drawing. They have no exceptions, they can be delineated so as to appeal directly to the eye, and, therefore, form an excellent means of introducing the nature of a definition to a child's intellect.

Such are the educational advantages which may be secured, in part or wholly, by everybody who can benefit by learning the other subjects of school work.

The capacity for learning to draw is just as widely diffused as the capacity for learning reading or arithmetic, and just as everyone can acquire some knowledge and skill in those subjects, so everyone can attain to some proficiency in drawing.

People who have not been taught to use the facilities which drawing affords, have to go through life deprived of a very important means of communicating with their fellow creatures. The interest in drawing which, by nature, children feel, should be cherished and encouraged so that it will continue throughout school life as a help to education, and that afterwards it may bear fruit in increasing the capacity for enjoying the beautiful in nature or in art, and making easier such art work as the vocations of life require. To be able to make a drawing of an object, showing its correct dimensions, is a power which everyone at some time or other, needs to employ. Skill in this simple kind of drawing is, however, by no means common. Men and women of education and culture think it no discredit to have to call in the aid of a workman to do their measuring. The mistakes not infrequently made by the workman do not much disturb his serenity, however they may affect his employer, who has to bear the loss occasioned by them.

Drawing ought to be made an essential feature in every child's education. Too much must not be expected from the average pupil. Great excellence of manual execution cannot be attained by children. Many pupils have great intelligence, but little manipulative power; they can learn to draw in a way useful to themselves, and which aids the development of their faculties, but great excellence of workmanship is, with them, out of the question. Were manipulative excellence insisted upon at each stage, all energy and liking for drawing would be exhausted at the very first step. No one should be careless. The teacher may be satisfied if the pupil works up to the limit of his or her capacity. Where there is improvement there is hope.

Every youth should have a chance of showing his or her full capacity in each subject. It is pretty well known that children who are slow and inattentive in the usual school-work may still have special aptitude for music, drawing, or the like. They should have a chance of distinguishing themselves in their own line without having to pass, as a preliminary, a difficult examination in other subjects for which they have little or no ability. Pupils of this description need careful management, as they are precisely those who lose interest and become listless if required to plod through a course of work which they find distasteful.

Perfection must not be expected in first efforts, however simple, and throughout the course the development of mere manual skill should not be regarded as the chief end in view, the aim being rather to give that culture which requires the use of drawing as the means or vehicle for conveying and expressing ideas.

Class or Collective Teaching.—The necessities of school management require that a large body of pupils shall be taught in mass, collectively, or as it is termed, in class. Languages, mathematics, and the like have for many years been made to conform to such treatment. In order that all may learn to draw from objects or casts, it is necessary to find methods that will make it possible for the teacher to demonstrate as easily, as a rule of arithmetic may be explained, the correct drawing of an object or cast, exactly as it appears to the eye of each pupil.

There is very little doubt but that good collective teaching is more beneficial to the learner than the method by which each individual is taught separately, and no doubt at all as to the economy in time effected. With collective teaching each member of the class is being taught during the whole of the lesson, whilst by individual teaching each pupil, even with good management, is taught for only a minute or two during the same period. In collective teaching the progress of one's neighbour acts as a stimulus or warning, and its system of question and answer displays the subject from more points of view than would occur to any individual working alone. Lastly, the collective method greatly tends to make the teaching systematic.

Four conditions are essential to the complete success of collective teaching from objects or casts.

1. Good classification.
2. An object which all can easily see.
3. Approximately the same view of the object for all the members of the class.
4. A teacher well acquainted with class management and with the subject, and able to demonstrate the principles to be learned and methods to be followed with clearness and enthusiasm. Instruction without enthusiasm is scarcely worth the name of teaching.

As many of the class-rooms in which drawing is taught are small, the second condition is often impossible of realisation. This difficulty may be got rid of, however, by supplying every pupil with a reproduction of the same card, object, or cast, and causing each example to be placed precisely in the same relation to the eye of each individual.

The teachers of drawing as a means of education.—Bearing in mind what has been already said, it is safe to say that the teacher must have a knowledge of the general principles of school teaching, skill in teaching a class by collective methods, and such a general education as will conduce to the due realisation of the inter-relation of drawing with those school subjects which help it or are helped by it.

Such a teacher should be either a professional schoolmaster or schoolmistress, who has made a special study of drawing, or an art-student who has had a good education, and who has acquired a knowledge of the principles of school teaching and skill in teaching a body of pupils collectively.

Some people, especially some artists, laugh at methods of teaching drawing. It would be just as wise for grown people, who read without effort, to ridicule method in teaching that art to children. The effort to learn to read is so great that anyone but a child is tired out by it, yet teachers constantly instruct 40 to 50 children simultaneously, and in a comparatively short time they all learn to read. If good methods produce this result in reading, why may not good methods be found for teaching drawing. Many artists prefer to rely on a sort of divine geometry—which measures nothing and takes no heed of exactness in number and proportion—instead of using what may be named the geometry of man. If they teach they say to beginners, get a likeness; be only anxious about the masses; get the character or feeling of the model. If you fail to get your work right at once, clear the board and try again. But those experienced in the training of young people know that they must walk before they

run, that they cannot draw as artists do, who have been years obtaining the skill which they display in a stroke. An experienced draughtsman can make up his mind what to do excessively quickly, almost unconsciously, but the beginner cannot proceed with the same ease. It is necessary to furnish him or her with methodical and connected exercises, which will bring him or her, in time, to judge proportions at sight, or almost instantaneously. The finished artist, inexperienced in school teaching, forgets what he had to go through to acquire his power. There are artists also who cannot be called finished, who have indeed but a very narrow idea of the range and resources of drawing, and it is these who are the most likely to wish for teaching. How many art students have been disheartened by the paradoxical way in which those artists who have not given themselves the trouble to think out and systematise their ideas deliver their dictums. Intelligent pupils get weary of a course of drawing, if they see that it lacks the method and system which they find in other subjects. A good teacher keeps boys and girls enthusiastic by giving them enough to do, by making the work interesting, and by rousing their curiosity and their constructive faculties. Interest in a course of study is soon lost if there is any loitering, or if it is continued too long after the freshness of novelty has passed. We learn few subjects finally. Those which interest us, or which we find useful, we probably return to again and again as years roll on. Many promising pupils are spoilt by the favouritism or injudicious praise of inexperienced teachers. Praise should only be given for that which costs self-denial and application, and not for latent talent, which costs the possessor nothing.

The possibilities of communicating knowledge and skill in drawing are not so narrow but that they will amply supply an extended school-course. Drawing, well taught, should be an intelligent record of facts and impressions. There is as much, and a like difference, between a good and a bad drawing of objects, as they appear to the eye, as between an excellent and a wretched literary description. We cannot implant inventive genius and delicate feeling for art-work where the germs of it do not exist, but we can bring to the knowledge of a student something of the accumulated experience of past and present ages. There are certain processes, certain facts, of form, light and shade, tone, texture, colour, and elementary design, which form the elementary grammar of art, and these should be acquired to some extent by all, whatever may be the ultimate aim of giving such instruction. This grammar is capable of being taught systematically, like reading, writing, arithmetic, and the like. Just as these subjects are taught side by side, having each an allotted time, to large bodies of pupils, so may the different elements of drawing be taught.

An ideal course of study would be somewhat as follows:—

The drawing of anything that interests a small child.

Memory drawing, letter pictures, and writing.

Use of the ruler.

Drawing to scale, with explanation of maps and diagrams.

The judgment, at sight, of length, proportion, height—compared with width, and angles.

Outline-drawing from flat objects seen unforeshortened.

Colour matching. Use of colour in maps, diagrams, &c.

The elements of practical geometry.

Statistical geometry, and the arithmetic of space.

The difference between real form and apparent form, as exemplified by the easier straight-lined geometric forms, as found in common objects, and simple curves, lying in one plane.

Elements of solid geometry as illustrated in plans, elevations, and sections of common objects.

General review of the application of the various kinds of drawing.

Representation in outline of common objects as seen by the eye.

Description in outline of the appearance of plants, and casts of fruit, vegetables, and animals.

The simple principles of light and shade as shown by contrast, reflected light, aërial perspective, tone and texture in connection with monochrome objects.

The same, as exemplified in groups of objects which differ considerably in colour.

Water-colour painting from objects.

Drawing and shading a head from the antique in chalk.

The simple principles of surface decoration.

Many pupils could only, as teaching is at present, obtain the broad outline and general principles of such a course as this. With the

getting of so much, come the aforesaid educational advantages, such skill as is useful to everybody, and that intelligent knowledge of the rudiments of art work which increases the power of appreciating works of art. The designer and the artist have too long been hampered by the want of knowledge on the part of the public. Cultivate the taste of every boy and girl, and it will become much easier for the art-worker to travel beyond the beaten track of obvious and commonplace conventionality.

Some pupils, with fair talent, will obtain that amount of skill which is the necessary preliminary step to the technical drawing of various professions and industries. Medical students who cannot draw are found to be heavily handicapped in competition with those who can.

It is unnecessary to mention the requirements of architects, engineers, and the like. The individual who can draw with ease and accuracy, can gain skill in any kind of manual industry much more quickly than would be possible without such power. The drawing of an object is an excellent preliminary to the making of the same. The acquirement of accuracy in measurement produces habits of precision that directly lead up to skilful handicraft. The difference between the skilful and unskilful workman is mainly that the former fashions his products the exact size required, and the latter makes them wholly or in part too big or too little for their purpose, and so wastes time and material for which the employer pays. It has been said that nine-tenths of English workmen cannot understand a plan, elevation, or section. Waiting for the foreman's explanation increases the cost of production by wasting the workman's time.

Pupils who have decided talent for pictorial representation will lay a foundation upon which to build up, on leaving school, a thorough-going training in drawing and painting, such as will enable them to truthfully represent whatever is placed before them. So much power every artist should have as a preliminary to the painting of pictures. Poets, authors, musicians, dramatists, and painters all have a tale to tell, and each tells it in a way most suited to his faculties. We do not ask the poet to present his subject as an oratorio, nor the dramatist to develop his ideas with a palette and brush. We do expect a man when he has chosen by what means he will introduce his theme, to show acquaintance with and skill in the use of the medium of his choice. Indeed, so much is such skill appreciated, that many works of art support a reputation, not on account of the subject, but because of the technical skill displayed. There are pictures that delight artists, and no one else.

For nine years I was in charge of the Art Department of the Bradford Grammar School, and for six years of that time I also taught at the Bradford Girls' Grammar School. During this period the pupils had to begin the study of drawing by the exclusive practice of what is often spoken of as freehand. By various devices I strove to awaken and sustain an interest in its practice, but with indifferent success. It is wearisome to clever pupils because it requires so little intellectual effort, and uninteresting to the ordinary boy or girl. The process of lining-in, however necessary for professional designers, chromo-lithographers, or engravers, cultivates in the young an unfeeling, mechanical method of dealing with a sketch which proves destructive of its best qualities. Those who have had long preliminary practice in the lining-in of freehand acquire a habit which is most pernicious, and difficult to get rid of in after studies. Why should decorative or conventional arrangements of plants be given to a child before it has any power of drawing natural plant form itself? As in other educational matters, the proper way is to proceed from the known to the unknown. Our first lessons in drawing should be from things familiar and interesting.

Curiously enough, when I was asked, on my coming to London, to visit a number of High Schools, in order to find out why the drawing languished, I found the excessive practice of freehand was the chief cause of the mischief. I quote the written opinion of the head of a school as showing the general experience:—"The continual practice of freehand is decidedly cramping to the pupils, and gives them a distaste for drawing." On receiving this confirmation of my own experience, it became a duty to devise a method of teaching drawing entirely from objects. This system has met an acknowledged want in so far as is shown by the fact that many schools are working according to it, and from other schools in different parts of the country inquiries are frequently received.

The exhibition just closed at Lytham-house, St. Alban's-road, Kensington, showed how it is being worked in the schools of the Girls' Public Day School Company.

Some of the drawings exhibited in this and previous years are on the walls.

A most important point to remember is, that these drawings are entirely the work of school-girls. The teacher has not assisted in the manipulation or mechanical execution of them, but has been strictly limited to giving advice.

The characteristics of the annual exhibition are as follows:—

1. Each school sends a certain number of careful drawings, illustrative of the work of the six divisions.

2. No pupil may send more than one drawing.

3. The drawings are certified by the head-mistress as being the unaided work of the pupils themselves.

There is also an annual examination, the main features of which are as follows:—

1. The teacher's power of giving a class or collective lesson is tested.

2. There is a succession of easy stages, one of which can be mastered each year by an average pupil.

3. Special provision has been made for talented pupils by the introduction of an honours paper in each of the divisions.

It may be well to state the aim of the work of each division, beginning with the most elementary.

Division I.

1. To develop accurate observation.
2. Connect writing and drawing.
3. Ward off colour blindness.
4. Cultivate the perceptions.
5. Teach outline drawing from *real objects*, which present no difficulties in foreshortening.

Division II.

1. To call attention to the difference between the real and apparent form of simple objects and curves.
2. To cultivate the graphic memory.
3. By the *dictated drawing* to insure a knowledge of art terms, and give facility in working from verbal instructions.

Division III.

To teach the leading principles of drawing in outline the apparent form of the things of every-day life.

Division IV.

To develop a useful power in drawing from rounded objects (plants and casts), that will serve as a stepping-stone between drawing from simple objects, and drawing from the antique.

Division V.

To give a knowledge of shading from real things. This will materially assist the pupil in acquiring the principles of painting.

Division VI.

To enable those who have shown capacity sufficient to pass the aforesaid divisions, to begin the study of the higher branches of art.

It may be mentioned that a pupil in one of the schools had a picture hung in the Royal Academy at the same time that she passed in Division VI. of the course just sketched This picture was painted in the afternoon class of the school by an ordinary school-girl.

Many of those present may take interest in the teaching of drawing sufficient to induce them to read the various speeches and paragraphs, which appear in the daily papers, respecting the advantages of introducing it into schools. Many may also have noticed how slowly we move in such matters in England. It would not be far wide of the mark to say that the teaching of drawing in nine-tenths of our higher schools is simply a farce when compared with the teaching of the other subjects.

The late Right Hon. W. E. Forster once said that the English people had a way of being late in every new educational movement, but that we generally managed not to be too late. We are certainly late in the matter of teaching drawing.

It is said by some that Englishmen are wanting in artistic feeling, and that it is no use wasting an art education on them; and others go so far as to say nothing can be hoped for in our climate. Yet we stand first in landscape painting, and in painting in water-colours we are still without an equal. Can the descendants of the men who built our cathedrals be without art feeling? When England and its rivals have reached that stage in educational development when nothing that can be done is left undone, then those qualities of invention and imagination which have given such diversity to our school of painting will enable us to carry off the palm.

If I have succeeded in making clear the importance to general education of teaching drawing to every boy and girl, it is to be hoped that fewer in the future will have to go through the world without the aid of that marvellous descriptive power which it affords.

The capacities of the young are a mine of wealth from which it is to our interest to extract the ore. The faculties which are chiefly exercised in drawing can be developed easily in childhood, but with difficulty in adults. Let it not be said of us that we refused to work a vein of precious metal until all chance of working it successfully had passed away, for there can be nothing more depressing to a parent or teacher than that a boy or girl should, in after life, be able to point out wasted hours and wasted opportunities of school life.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said the paper was very suggestive, inasmuch as it treated the subject from a new point of view. There was no necessity, at any rate in that room, to dilate on the importance of drawing itself, but sufficient stress had not been laid upon it as a means of developing the faculties of children. There were two objects in education, first teaching something which would be useful in after life, and, secondly, the training of the mind. The uses of drawing were obvious, but it was a novel point to insist upon it as a method of training a child's faculties. He had often heard it alleged as a reason for not teaching drawing, that there was no time for it, that all the time available was required for other subjects more useful as a means of education, but if Mr. Ablett could show that it was not only useful for its own sake, but also in developing the growing faculties, that objection would be to a great extent removed. He did not think any amount of training would prevent colour blindness, as that was pretty generally acknowledged to be due to a defect in the retina. He believed there were several gentlemen present connected with education, and he hoped they would ask any question which might occur to them. When looking at the drawings of the little boy, it occurred to him that if he were not taught he certainly must have lived in an artistic environment, and he did not quite see how children who were not so fortunate were to be encouraged to draw; he referred especially to the children of the lower classes.

Surgeon-Major INCE, M.D., said this was one of the most interesting papers he had ever listened to, and treated on a subject of vast importance. The art of drawing was as natural as eating and drinking, and only required that the child should have the opportunity of carrying out its natural instincts. Writing was much more difficult than simple drawing, as was evidenced by the pictures on the wall. Mr. Ablett had referred to the alleged over-pressure on children as one of the excuses for not teaching drawing, but as a medical man, he said this idea was a mere fad, as fallacious and unreasonable as the rage at the present day for excessive sanitation. Some inspectors of schools favoured the idea, and some eminent medical men stood forward as the champions of children suffering from over-pressure, but he maintained there was no such thing—mere differences of constitution and strength in children, but those who appeared to be jaded and over-worked would show the same symptoms under any other form of exercise. The present curriculum was absurdly limited in comparison to that in German and French schools, and he entered his protest against the idea altogether. He believed the complaint was mainly made by the teachers, but it was very easy for a parent or teacher to see when a child was unfit for a full task, and act accordingly. Taking the ordinary run of children, the amount of work exacted from them was ridiculously small.

Mr. W. E. SPARKES thought the last speaker could not have much practical knowledge of elementary education. He had taught for seven years under the London School Board, and he asserted that there was over-pressure, both of the teachers and children; it was inevitable that it should be so, when all children, no matter what their natural ability, had to be brought up to one dead level. He had the greatest admiration for Mr. Ablett, who taught drawing more clearly and intelligently than any one else he had ever met with, and he believed his methods had proved successful wherever they had been tried. They were adapted for the kinder-garten system, and might be introduced in connection with the teaching of almost all subjects, except those of an abstract nature, like grammar.

Mr. H. MITCHELL said he was not a teacher but a designer, but he had always felt that whatever knowledge men had was of very little use unless they were able to impart it to others. Now there were only three modes of doing this, by speaking, writing, and drawing, and in nearly all our large schools these three arts were almost entirely ignored. How many men were ever taught elocution? He would not say anything about the pulpit, but almost the only men who could impart any pleasure by elocution were on the stage. Writing, again, was as a rule disgraceful. He knew one head master of a large public school who used three characters to sign his name; another great man at Balliol used to stick up notices that no one could read; and in London the head master of one of the largest schools used to send notes round to the different masters to read to the classes which no one could decipher. The drawing was almost as bad as the writing, and all this would continue until the masters who taught these three means of communicating knowledge had a higher status than at present. Drawing was generally taught on half-holidays, when the boys naturally took no interest in it. The only idea, nowadays, seemed to be to pass an examination; but this was a great mistake, and so it was to consider that all knowledge worth having was

to be obtained from books. It had been said that a man with money in his pocket could get anything he wanted, but that was not so if he did not understand the language of the country where he was. His education was gained in the good old days, and his French was only passable, and his German very bad, but he found drawing a universal language, and by making a rough sketch he could always obtain what he wanted.

Mr. PITT thought it would be impracticable to interlace the teaching of drawing with other subjects, as Mr. Ablett had suggested—speaking of elementary education—because the time of the children of the working classes at school was so short, generally from the age of five to seven, that there was barely time to get through the ordinary curriculum; but, on the other hand, there were subjects which might, with great advantage, be cut out, and drawing substituted. He was told that in many London schools the inspectors went round and were delighted if they could get from the children the name of every little river in the kingdom, and the heights of all the mountains in the world. That kind of instruction only burdened the memory, without strengthening it. On the Continent the education was much more practical and constructive. Children should be taught those things which would enable them to acquire any knowledge they might want in future life; the school should be a sort of gymnasium for the mind. The main idea he wished to press upon those who had any influence in the matter was that a great deal of the curriculum in London elementary schools might be got rid of, and something constructive, such as drawing, put into its place, and possibly a foreign language. In Germany he could converse with a schoolboy in English, and in Belgium he believed most children learned three languages—Flemish, French, and English. There was no need to add anything as to the value of drawing after the paper they had heard. Wherever drawing was taught systematically it was the most popular subject, and in elementary schools, where it was taken up with zeal, he was told that it was a real pleasure to the children, even in the poorest parts of London.

Mr. J. B. RUNDELL wished to be allowed to say that, in his opinion, Mr. Ablett had made it clear that so long as all infants in this country were not carefully and intelligently taught to draw before or at the same time they were taught to write, so long would this nation continue to deprive itself of an incalculable amount of material and intellectual wealth.

Mr. S. S. BROMHEAD thought the subject had been discussed rather too exclusively from the elementary school standpoint, for a great many of the valuable hints which had been given would apply equally well to middle-class schools. As a parent having boys from 12 to 15 at school, he could say that the way in which drawing was taught was lamentably deficient, and in a great measure he believed it arose from the teachers not having sufficient patience and consideration for the short-coming of beginners. He ventured to think that a teacher should rather encourage a pupil, and that one who was backward would, under such treatment, be much more inclined to persevere. He thought a good plan would be, for the teacher to show the class some simple object, and tell them to bring a drawing of it the next morning. He had heard it stated in that room that no Government grant was obtained for teaching drawing, however good might be the results, and if that were so, there was not much inducement to masters to teach it. He agreed with a former speaker, that there were several other subjects which could be much better spared.

Mr. TREWBY said it seemed to have been forgotten that the short time boys in elementary schools had to be taught, would not allow of any great skill in drawing being attained. Art education in elementary schools ought not to be the subject of a Government grant. The boys and girls should be simply educated up to the point of being able to talk their own language. If they could make a rough drawing of that kind, it would be quite enough, and their own aptitude, by-and-bye, would lead them on to something better; and they could get further instruction in the Government Art Schools. With regard to the bad writing of some public men, he thought it was in great measure due to their having had to write so much Greek.

Mr. W. A. BARBER said the paper was very valuable, but it did not touch on the scientific part of the subject. In his business he frequently got drawings of a very high class, but not carried out in a scientific manner. In furniture, for example, an architect might produce a very beautiful chair to harmonise with the fittings of the house, but perhaps it would be ill-constructed as a chair. He did not mean to say that all architects should learn chairmaking, but a certain amount of science should accompany a knowledge of drawing. He thought the examples shown of what had been done by a little boy of three and a-half were rather to be avoided. No doubt the child could do it, he thought many children could, but he would probably have done much better if he had had a little systematic instruction, and had not been left simply to amuse himself how he liked, a few minutes at a time. Drawing ought to be taught to all children; he had often to do with boys who left school with several certificates, and did not know what a straight line was. The writing of the present day was not nearly equal to that of school children fifty years ago.

Mr. NEWTON remarked that not a word had been said about mechanical drawing, the most important of all in some respects, and a style of drawing which could be learned by anyone; everything was done by rule and measure. They were told that drawing

was a universal language which everyone could understand, but he constantly met educated men who could not read a mechanical drawing. It could be taught to anyone, but as far as he knew it was taught nowhere. It would not only train the eye and the mind to accuracy, but would be immensely useful in after life. Those who had anything to do with working mechanics knew how they struggled sometimes to get an idea of their own into intelligible shape; they wasted time and money in making models which would not act. Whereas a little knowledge of mechanical drawing would enable them to put their ideas on paper, and if there was anything wrong it would be seen at once, and could be easily put right, without the waste involved in making a useless model.

The CHAIRMAN, in proposing a vote of thanks to Mr. Ablett, said it seemed universally acknowledged that in this country, at any rate in elementary schools, sufficient attention was not given to drawing. He would ask Mr. Ablett whether in his opinion the practice of drawing would have a beneficial effect on handwriting; he rather doubted it himself, as he knew some eminent artists who wrote most execrably.

The vote of thanks having been carried unanimously,

Mr. ABLETT, in reply, said he certainly thought the teaching of drawiug would materially assist the formation of a good handwriting. The reason why boys in the higher schools wrote so badly was because they were so badly taught to begin with, and afterwards they had so much writing to do that their hands, even if tolerably formed, got ruined. When he was at school he had rather a talent for writing, but the head master rather scoffed at it, and he had so many impositions to write that his hand got spoiled, and he had never recovered it. He had known university men who had done a great deal of Greek, who wrote a very fine legible hand. It was an interesting subject how far colour blindness went, but there was a deal of difficulty about it. One of her Majesty's inspectors, writing to the *Times* lately, said he had never known a case of colour blindness where a good training had been given in the infant school; on the other hand, he knew a case of a gentleman who had written a book on colour, and all his sons were colour blind. It seemed to be the fact that some people had not the rudimentary power of matching colours, while others had the rudimentary power, which was capable of development. He believed that no girl was ever known to be colour blind, and he was inclined to attribute that to the fact that girls got much training in matching ribbons and wools when young. He had been much interested at hearing two opposite opinions about the drawings he had exhibited. The Chairman thought no child who had not the advantage of an artistic home could do them; and another gentleman thought any child could. He was very glad to learn that, because that was his own idea. He only brought them with a view of showing that if a child were encouraged and allowed to draw he would be able to produce drawings of that description. With regard to mechanical drawing, he had made reference to it, and pointed out the importance of teaching practical geometry, and encouraging the use of the rule as early as possible. The majority of these drawings were done with the aid of a rule; the little boy seldom drew animals, because of the difficulty of the curves, which he could not draw so well as straight lines. With respect to the interlacing of drawing with other subjects, his view was that if drawing were interlaced it would assist the pupils in learning other subjects, such as geography, history, &c., and while learning them they would also be gaining power in drawing at the same time. Drawing from memory was largely practised; the boys and girls had been asked to look at a certain object during the week, and then the first ten minutes of the lesson they were told to draw what they had observed. Until quite recently drawing was not recognised by the Education Department, but was handed over to the Science and Art Department; then Mr. Mundella, on the recommendation of the Royal Commission on Technical Instruction, introduced it as part of the code; but by some means it had got turned over again to the Science and Art Department, which he much regretted, because whilst this was the case it would never be regarded as an essential subject.

Miscellaneous.

PRODUCTION OF INDIGO IN CHINA.

Consul Jones, of Chin Kiang, in his last report, says that the indigo plant is cultivated as part of the crop of every farmer in that province, and upon its manufacture into the dye, is employed by his family for dyeing the cotton goods used for the clothing of the people. That which is not consumed in this way is put upon the market for sale and exportation. The indigo is a leguminous plant, easily cultivated, of prolific growth, and little subject to disease or the ravages of insects. The ground is prepared by the plough and harrow, thoroughly pulverised and enriched by liquid manure, which is in common use by the Chinese in the cultivation of all their crops. As in the cultivation of rice, the seed of the indigo plant is sown in patches of ground and as thickly as possible. In a month, when the plants are several inches high, they are transplanted into a larger piece of ground, and in rows about eighteen inches apart. From that time until they are required they need very little care, with the exception, in a scarcity of rain, of being occasionally watered. When they

reach a height of about two feet and the leaves have assumed a dark rich blue colour, they are cut to the ground and gathered for the manufacturing process. From the roots when the plants are cut down another growth springs up, and two crops are obtained in the year. In every farm there are a dozen or more large earthen jars or *kongs*, with the capacity of a barrel, which are used for the manufacture of indigo. Those who engage extensively in the manufacture have a large brick-lined tank built in the ground, six or eight feet in depth, and of a diameter of ten or fifteen feet, with a capacity of many hundred gallons. The plants are placed in these receptacles and covered with fresh clear water, where they are allowed to lie for several days till the *indican*, a peculiar substance contained in the juices of the plant, is decomposed by fermentation. This process is aided by the application of a little slacked lime and frequent stirring, when the indigo is precipitated in the form of a dark blue sediment, which when dried forms the indigo of commerce. The quality of the indigo is characterised by its colour, the richer and darker the blue the more it is esteemed, and the higher prices it will fetch in the market. During the process of manufacture, women with flowers in their hair (a universal custom in China) are not permitted to approach the *kongs*, as it is a belief that their presence is prejudicial to the quality of the indigo, and for a like reason the *kongs* are removed to a situation protected from the atmosphere of the fields.

Obituary.

Sir Alfred P. Ryder, K.C.B.—Admiral Sir Alfred Phillipps Ryder died on Monday, May 30th, by drowning, having fallen off the steamboat pier at Vauxhall. He was born at Wells, 28th June, 1820, the son of the Hon. and Rev. Henry Ryder, sometime Bishop of Lichfield and Coventry, and he entered the Navy in 1833. In 1847, he was employed in North America and the West Indies, and was in command of the *Dauntless* in the Baltic during the Russian War, 1854-5; was Comptroller-General of the Coast Guard, 1863-6; Commander-in-Chief in Chinese Waters, 1874-7; and at Portsmouth, 1879-82. He was created a K.C.B. in 1884. Admiral Ryder was elected a member of the Society in 1870, and a member of the Council in 1883, but was unable to accept the office on account of his other duties keeping him from London. In November, 1873, he drew attention to the need of a satisfactory revolution indicator for steam-ships, and at his instigation a committee was appointed and prizes offered for one; the prize (a gold medal) was awarded to Mr. T. A. Hearson, for his strophometer, in 1876. He was a member of the Committee on Life Saving Apparatus, which was formed on his suggestion. A gold medal was awarded to Messrs. J. and W. Birt on the recommendation of the committee in June, 1879. He was chairman of the Committee on the Prevention of Collisions at Sea, appointed 1883, and his Preliminary Report was printed in the *Journal* in May, 1884. He was also a contributor to the *Journal*.

General Notes.

City of London College.—A Russian class has just been started at the City of London College, Moorfields, under Professor N. Wassilieff Tchaykovsky, B.A. The classes are held on Mondays, at seven p.m., and men and women are admitted. In connection with this, it may be mentioned that the Society of Arts Examinations are open to students of any language, wherever a sufficient number of names are entered.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

May 9.—"Locks and Safes." By Samuel Chatwood. The Lord Grimthorpe will preside.

May 16.—"Electric Lighting from Central Stations." By R. E. B. Crompton. The Attorney-General, M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings, at 8 o'clock:—

May 15.—"Emigration." By James Rankin M.P.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

May 8.—"The Decorative use of Colour." By J. D. Crace.

May 29.—"Persian Textiles." By Cecil Smith.

Indian Section.

Friday evenings, at Eight o'clock:—

May 4.—"The Injurious Effects of Canal Irrigat on on the Health of the Population of the Punjab." By Surgeon-General H. W. Bellew, C.S.I., C.I.E. Sir Joseph Fayrer, K.C.S.I., will preside.

The above dates are liable to alteration.

Cantor Lectures.

The Sixth (and concluding) course is on "Decoration." By G. Aitchison, A.R.A. Three Lectures.

Lecture II.—May 7.—Decoration: the Strict Following of what Nature teaches in adorning her

Works.—Delineation of Living Forms: province of Sculptors and Painters.—Colour the Common Province of Architect and Painter.—Employment and Improvement of Present Materials and Manufactures for Decorative Purposes.—Health: as affected by use of Materials External and Internal.—M. C. Garnier's Dream of a Decorated Paris not impossible in London.—Enamelled Pottery.—Use of Opaque Coloured Glass.—Mosaic.—Pietra Dura.—Sgraffito.—Metals for External Use.—Marbles.—Value of Good Workmanship.

LECTURE III. — MAY 14.—Stained Glass.—Enamels.—Woodwork, including Carved, Turned, and Inlaid.—Woven and Felted Fabrics.—Leather: Embossed, Painted, and Lacquered, and Cuir Bouilli.—Imitations of, and Substitutes for, Leather.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. Aitchison, "Decoration." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Edward Perrett, "Filtration by Machinery."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. J. Dibdin, "Standards of Light."

British Architects, 9, Conduit-street, W., 8 p,m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. M. Maspero, "The Results of Many Years' Investigation into the Extent of Egyptian Conquest under Thothmes III. in Southern Palestine." (With comments by many Egyptologists)

TUESDAY, MAY 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. D. Crace, "The Decorative Use of Colour."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Gardiner, "The Plant in the War of Nature." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Adjourned Discussion on Mr. E. B. Ellington's paper, "The Distribution of Hydraulic Power in London." 2. Mr. Crawford Barlow, "The Tay Viaduct, Dundee." 3. Mr. W. Inglis, "The Construction of the Tay Viaduct, Dundee."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Hotel Métropole, Whitehall-place, S.W., 8 p.m. Sir William Wilson Hunter, paper on "The New Industrial Era in India."

Mineralogical, Geological-museum, Jermyn-street, S.W., 8 p.m. 1. Mr. J. J. H. Teall, "Notes on some Minerals from the Lizard." 2. Mr. H. A. Miers, "Contributions to the Study of Pyrargyrite and Proustite," with Analyses by Mr. G. T. Prior. 3. Prof. E. Kinch, "Cornish Dufrenite." 4. Prof. T. G. Bonney, "A peculiar variety of Hornblende from Mynydd Mawr, Caernarvonshire, and on a Picrite from the Clicker Tor District."

WEDNESDAY, MAY 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Samuel Chatwood, "Locks and Safes."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. E. Marr and Prof. H. A. Nicholson, "The Stockdale Shales." 2. Mr. Alfred Harker, "The Eruptive Rocks in the Neighbourhood of Sarn, Caernarvonshire."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Dr. A. C. Stokes, "New *Infusoria Flagellata* from American Fresh Waters."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Huguenot Society of London, Criterion, Piccadilly, W., 8 p.m. Mr. W. M. Beaufort, "The Last of the Huguenot Churches."

Patent Agents, 19, Southampton-buildings, W.C., 7 p.m. 1. Discussion on Mr. Hardingham's paper, "The Proposed Patent-law in Switzerland." 2. Mr. J. Imray, "Patent Claims."

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Paper by Prof. John Rhys.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual Meeting.

THURSDAY, MAY 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 2 p.m. Conference on Canals and Inland Navigation.

Society for the Encouragement of Fine Arts, Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture V.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Preece, "The Risks of Fire Incidental to Electric Lighting."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 2 p.m. Conference on Canals and Inland Navigation. (Continued.)

United Service Inst., Whitehall-yard, 3 p.m. Captain F. G. Stone, "The Formation of Volunteer Field Batteries for Home Defence."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Prof. W. Chandler-Austen, "Some curious Properties of Metals and Alloys."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. Frank Marshall, "The 1695 Quarto of 'Hamlet.'"

SATURDAY, MAY 12 SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. Conference on Canals and Inland Navigation. (Conclusion.)

Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thompson, "Note on the Condition of Self-excitement in a Dynamo Machine, and Note on the Conditions of Self-regulation in a Constant Potential Dynamo Machine." 2. Mr. W. E. Ayrton, "Note on the Electrical Action of Light." 3. Mr. T. H. Blakesley, "The Theory and Practice of Applying the Dynamometer to the Investigation of Transformers." 4. Profs. W. E. Ayrton and T. Perry, "Measuring the Electromotive Force of Dynamos and Moters."

Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (With Vocal and Instrumental Illustrations.) (Lecture V.)

Journal of the Society of Arts.

No. 1,851. Vol. XXXVI.

FRIDAY, MAY 11, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor G. Aitchison, A.R.A., delivered the second lecture of the sixth and concluding course on "Decoration," on Monday evening, 7th inst.

The lecture was illustrated by specimens of wrought ironwork, lent by Messrs. Starkie Gardner and Co.; of marble, by Messrs. Farmer and Brindley; of modern marble wall mosaic, by Messrs. Burke and Co.; of modern glass wall mosaic, by the Venice and Murano Glass Company; of modern enamelled pottery and lustre ware, by Messrs. De Morgan and Co.; and of canvas plaster, by Messrs. G. Jackson and Son.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen, in certain classes of art-workmanship, under the following conditions:—

1. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—
   (i.) Copies of existing works.
   (ii.) Modifications of existing works.
   (iii.) Original works.

It should always be stated under which heading (i.), (ii.), or (iii.), the objects are to be entered.

4. In awarding the prizes, the judges will take into account the following points:— 1. Originality or beauty of design. 2. Fitness of treatment. 3. Excellence of workmanship.

5. Designs or working drawings will not be received in competition.

6. Before the award of prizes is finally made, the candidates must be prepared, if called upon, to satisfy the Council of their competency.

7. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

8. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for accident or damage of any kind.

9. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

10. All the prizes are open to male and female competitors on equal terms.

11. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

12. All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope, giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House or, if the necessary arrangements can be made, at the South Kensington Museum.

13. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the dis-

cretion of the judges. Certificates will be given to the winners of prizes.

The following are the classes in which prizes are offered for the Session 1888-9:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.

a. Thrown, not shaved, first prize, £5; second prize, £2.

b. Shaved or turned, first prize, £5; second prize, £2.

2. Decoration.

a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.

b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.

c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.

3. Stone salt-glazed ware.

a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.

b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for outside a window, a street-door panel, or for inside as a window screen, or for coil case, ventilator, &c.

Proceedings of the Society.

INDIAN SECTION.

Friday, May, 4, 1888; Sir Joseph Fayrer, K.C.S.I., M.D., F.R.S., in the chair.

The paper read was—

THE INJURIOUS EFFECTS OF CANAL IRRIGATION ON THE HEALTH OF THE POPULATION OF THE PUNJAB, AND THEIR REMEDY.

By Surgeon-Gen. H. W. Bellew, C.S.I.

It was my good fortune to hear the paper read at the meeting of the Society in this room on the 21st of March last, on "The Evils of Canal Irrigation in India and their Prevention," by Mr. T. H. Thornton, and subsequently, when invited by the committee of the Indian Section to read a paper at the next meeting of the Society, it at once occurred to me that I could not do better than follow up the subject so ably and clearly set before you on the occasion referred to. And the more so because, in the discussion that followed upon that paper, time did not allow of much consideration being given to the question of the practical remedies to be adopted with a view to the counteraction or mitigation of the injurious effects which, it was then so clearly shown, had been produced upon the health of the populations living within the areas affected by the faults of our canal systems in many parts of India.

I therefore propose, with your permission Mr. Chairman, to submit to the Society some remarks on the injurious effects of canal irrigation upon the health of the population of the Punjab, with a few suggestions of a practical kind, which are calculated to enable the people to withstand, in a more efficient manner than they have yet been able to do, the evil influences by which they now find themselves beset, through the changes in the climate of their country, which have been brought about by the effects of canal irrigation.

I may state at the outset that what I have to say is based upon the results of personal observation and experience during a period of some thirty years in the province to which my remarks are confined. Though, in all probability, the same state of things may be easily shown to exist in other parts of India, where the country has been similarly affected by canal irrigation.

In the Punjab, where my experience has been gained, the use of canal irrigation has everywhere proved detrimental to the health standard of the people. In some parts of the province this is more conspicuously the case than in others; but in general terms it may be said that, wherever canal irrigation has been introduced, there the health standard of the people has deteriorated to a more or less

appreciable extent ; whilst in some tracts, where the land has become water-logged through defective drainage, a very marked deterioration in the physique of the people is already a matter of local notoriety.

It is not my intention to substantiate any of these statements by an array of figures drawn from the mortality tables of the districts under canal irrigation, in comparison with the deaths recorded in the districts not so irrigated. For such an appeal to the statistics of the mortality registered in the province would be misleading. Because under the system of classification of death causes in force—however useful that system may have proved as affording in the rough a general indication of the causes of death amongst the people—there is no means of fairly comparing the mortality of one part of the province with that of another in anything like an accurate manner, except at the cost of great labour in the careful investigation and sifting of the records from which the statistics are tabulated.

The statistics of mortality amongst the general civil population in India are tabulated by the Sanitary Department under the six heads of "Cholera," "Small-pox," "Fevers," "Bowel complaints," "Injuries," and "All other causes." But, practically, not one of these specific headings—excepting only that of injuries, about which there can be no mistake—strictly represents the mortality actually occurring under that particular cause.

For instance, under the heading "Cholera," many of the deaths due to that cause, and especially in epidemic seasons of the prevalence of that disease, are classed under the heading "Fevers," and many again, under the heading "Bowel complaints," according to the diverse notions prevailing in different places as to what is and what is not cholera. Similarly with regard to small-pox; in some districts the registrars record under that heading the deaths due to small-pox only, whilst in others the deaths caused by measles are also classed with small-pox. So, again, with bowel complaints ; though the bulk of the mortality registered under this heading is really due to idiopathic diarrhœa and dysentery, the category also contains the deaths caused by the symptomatic diarrhœa of fever, especially in seasons when fevers are not epidemically prevalent ; whilst, as regards the heading "Fever," almost every acute inflammatory affection terminating fatally is classed under this very comprehensive term. Deaths from pneumonia, pleurisy, bronchitis, hepatitis, peritonitis, and a variety of other acute inflammatory diseases, are all commonly classed with the mortality caused by malarious and specific fevers ; and, in seasons of epidemic sickness, the list is largely swelled by the addition of deaths from cholera and influenza.

Thus it happens that, whilst the greatest portion of the total mortality from all causes is very unequally distributed under the five headings of "Cholera," "Small-pox," "Fevers," "Bowel complaints," and "Injuries"—fevers always comprising by far the largest portion — a comparatively small proportion is classed under the heading, "All other causes," which includes, or rather represents, the mortality from chronic diseases of all sorts, such as rheumatism, gout, leprosy, cancer, tumours, &c., diseases of women and childbirth, diseases of infants, teething, convulsions, whooping-cough, inanition, and so forth.

These defects in the classification of death causes in India, though they interfere somewhat with the deduction of accurate information from the registered statistics of particular districts in respect to the local climatic conditions attending such mortality, do not materially affect the general results with reference to the nature of the principal death causes for the whole province. This is exemplified in seasons of the general prevalence of epidemic sickness, when extensive areas—not always of continuous extent — are visited by particular epidemics, such as of cholera, measles, influenza, small-pox, pneumonia, or fevers, whether malarious or famine. In such seasons the excessive sickness and mortality are found to prevail quite independently of the normal character of the climate, so far as this is affected for good or evil by the existing conditions of the country in respect to the amount of cultivation, growth of trees, and the state of the soil from the nature of its drainage. But more directly in dependence upon the peculiarities specially characterising the meteorological features of the season itself; and which peculiarities may be said to comprise unusual degrees of heat and humidity in the air, with more or less of change and disturbance in its electric condition ; coupled also, very often with distress from high prices of food. So that districts habitually showing a very high death-rate often pass through such epidemic seasons with comparatively little or even may be, no increase of their normal mortality; whilst other districts, which usually enjoy a healthy climate and present a low death-rate, on such

occasions, are overtaken by an excessive amount of sickness and a very high rate of mortality.

Another reason for not relying too confidently upon the published statistics of mortality, as evidence of the injurious effects of canal irrigation upon the health of the people in the Punjab, is the fact that they afford no reliable means of discriminating between the mortality due to local climatic causes and that caused by periodically recurring epidemic influences; though the latter, there seems no doubt, is largely affected by the nature of the condition of the soil in the areas overspread from time to time by seasons of epidemic sickness and mortality. Yet this is not always so, as is evidenced by the incidence of cholera and enteric fever among our European troops and the native prisoners in our jails, the general populations around them at the same time enjoying a more or less complete immunity from such ailments.

Notwithstanding these drawbacks, however, the death statistics of the Punjab, taken as they stand, show a generally higher death-rate in the canal irrigated districts than in the districts not so irrigated. Whilst in particular districts, where the soil is more or less water-logged from defective or impossible drainage —notably along the course of the old Western Jumna Canal, in the Delhi and Karnal districts — the high death-rate and serious deterioration in the physique of the populations are matters of notoriety, and have for many years engaged the attention of the Government of India. Such extreme instances of the injurious effects of canal irrigation, under exceptionally unfavourable conditions of soil drainage, upon the health of the people are, however, happily, of exceptional occurrence in the Punjab.

More commonly the injurious effects of canal irrigation upon the health of the people living in the areas affected by the influence of such irrigation are not so manifestly apparent to the casual observer; nor, indeed, are they even properly understood by the people themselves, who know no more than that since canal irrigation was introduced on their lands they suffer much more sickness than they ever did before. The injurious effects are none the less real though, nor are they the less plainly traceable in the physical deterioration of the rising generation. Indeed, it is in this direction that we find more expressive evidence of the injurious effects referred to than in the indications afforded by a mere bald array of death-rate figures.

For several years past it has been a matter of comment amongst the intelligent classes in the Punjab that, despite all the elaborate machinery of the Government of India in the medical and sanitary departments, and their many costly measures for the improvement of the material prosperity of the country and of the welfare of its inhabitants, there has taken place a steadily increasing deterioration in the health standard and manly spirit of the people. I have frequently heard it said by old men of experience and intelligence—and the truth of their statements is to a large extent borne out by the results of my own observation in the country—that formerly they were little troubled by sickness, and that epidemic visitations of cholera and fever were matters of rare occurrence, and at long intervals; whereas now they are never free from sickness of one sort or another, whilst epidemic visitations of pestilential and death-dealing diseases are now matters of almost annually recurring frequency in some part or other of the Province.

In the rough and exciting times of the Sikh rule, they are fond of saying—and not unfrequently with a sigh of regret for the good old times, the bright coloured pictures of which they cherish in their thoughts with a natural and pardonable pride of race and country — in those times food was abundant and cheap, poverty was a thing that little troubled them, and sickness made no great impression on them; whilst the climate of their country was noted for its salubrity, and the people for their martial spirit and manly vigour. But now all this was changed.

In these degenerate days, though trade and commerce had enormously increased; though vast waterless tracts, which were formerly lying waste, or afforded pasturage for their cattle and a hunting ground for their youth, were now traversed in all directions by irrigation canals and their ramifications; and though cultivation and trees now appeared in many parts where, before, their absence was the predominant feature of the landscape; yet, with all these changes already effected and still in progress, they find that the benefits conferred by the new state of things are very largely overbalanced by many serious evils, not the least distressing of which is the very widespread extent of poverty, which presses upon the common people now with greater force than it was ever known to do in the good old times of their recollection. Their youth, they

say, who in the last generation were trained in the manly exercises of the field, in the practice of the various industrial arts and handicrafts, or in the stirring adventures of military life, are now cooped up in the schoolroom and taught new ideas, and thence entered upon a new world where but few found employment for their newly-acquired knowledge.

The picture, though faulty enough, is not altogether a fanciful one; for none knows so well where the shoe pinches as he who wears it. And so it happens that, amongst the reflecting and intelligent classes, it is a subject of common lament that, under our rule in India, the fabric of native society is gradually breaking up. The controlling influence of the priesthood—Hindu and Muhammadan alike—has lost much of its hold upon the minds of the people, without any compensating power to take its place, so that the moral restraints, which formerly controlled their conduct, are now in all directions broken through and defied with impunity. Many vices, which formerly were either promptly and severely punished by their laws, denounced by their religious teachers, discountenanced by society, or condemned by conscience, are now rapidly spreading among all classes, and permeating into the domestic circle. Sexual immoralities, the abuse of ardent spirits, unreasonable litigation, and neglect of religion, have all combined to undermine the fabric of society, to loose the ties of family and bonds of kindred, and to produce a state of disintegration, the drift of which nobody can understand.

But what has all this, it may be asked, to do with the injurious effects of canal irrigation upon the health of the people, which is the subject of my remarks. Well, directly it may have little or no relation to that subject; but indirectly the reference to these topics is not without a special bearing upon it, since it indicates some important features of the life conditions tending to predispose the people to the assaults of disease. Whilst, at the same time the allusion may serve to throw light upon the problem how to govern the country more in accordance with the true interests of the people than has hitherto attended the measures of our Government in that direction. Were the people taken more into our counsel, and allowed a fair participation with us in the active work of prosecuting the various measures we have introduced for the improvement of their welfare and prosperity, they would quickly acquire an interest in the success of our undertakings on their behalf. And, though their views as to what best suited the requirements and circumstances of the people might not always accord with our notions of the fitness of things, derived from the teachings of European science and education, still their employment as coadjutors in the work would afford them a motive for helpful exertion in the grateful task of their own regeneration; instead of, as hitherto has been the case, without that incentive, holding back in complete indifference or apathy, if not of offering a stolid and passive resistance.

In no department of our Government of India has this failure to enlist the sympathy and co-operation of the people been so glaring or proved so obstructive as in the workings of the medical and sanitary departments. But I need not do more now than touch very lightly upon this subject.

In a previous passage I have adverted to the notion, prevalent among the people of the Punjab, that since the establishment of the British rule in that country there has taken place a marked deterioration in the physique of the people—of the common people most especially—and that sickness has become a constant trouble amongst them, whilst epidemic visitations of disease occur now with greater frequency than before; and I believe that, although we have no records to show what was the ordinary or actual course of events in the Punjab in these respects prior to the British conquest, there is good ground to accept the popular notions referred to as being based upon a foundation of truth. For I have observed that the common people in Kashmir, and in Rajputana, as well as in the independent countries of Afghanistan, and Nepaul, present not only a higher standard of physical development and condition than the same class of people under our rule in the Punjab, but also appear to be less poverty-stricken.

However, be this as it may, our own records of the course of sickness and mortality in the Punjab, furnished by the Medical and Sanitary Departments, show that the operations of these departments have as yet affected very little in either mitigating the amount of general suffering from preventible causes of disease or in reducing the appallingly high death-rate obtaining in particular localities. On the contrary, the records tend to show that, if anything, both sickness and mortality have increased rather than diminished. These results, it may be said, are only apparent facts, and not real, the higher figures being attributable to the greater accuracy now attained in

the recording of statistics. But, on the other hand, it may be argued, with an equal show of reason, that the results are real and not merely apparent, being the consequence of greater attention paid to the tabulation of statistics than to the prevention of disease.

However, in considering this subject, it must be borne in mind that in the rough old Sikh times—though there may have been less general sickness amongst the people than under our peaceable rule, and a more happy immunity from epidemic visitations—there was undoubtedly not only a lesser rate of fecundity in the population in those unsettled times, but also a greater destruction of infant life which passed unnoticed, only the fittest to live growing up and constituting the people. Whereas under the beneficent rule of the British Government, with the enforcement of order and regularity, and the protection of life and property—which constitute its most prized characteristics—there is afforded not only greater scope for fecundity, but also a greater chance of living to the new-born; albeit without any regard to fitness in the individual for the battle of life. And hence the marked change in the physique of the people, to which reference has been made as being a matter of common observation; for with the incorporation amongst them of vast numbers physically unfitted for the successful struggle in life—although themselves by no means backward in propagating their like to take the same chances as themselves—there comes about a greater harvest for disease and death to gather in.

In this view of the case, it appears that, under our benign system of Government, the conditions of life surrounding the people are very eminently favourable to increase of population. But it does not appear that the conditions of life are of a kind to ensure the healthy growth and maturity of the increased numbers. Where does the defect lie?

With a question of this kind, beset as it is with complexities on every side, it is beyond the range of my remarks to deal. But I may observe *en passant* that insufficient clothing is, so far as I can judge, the great evil that lies at the bottom of most of the sickness and mortality, now more than ever, afflicting the people in the Punjab. Among the prosperous and educated classes great and rapid changes for the better have taken place during recent years in the matter of clothing; but amongst the agricultural and labouring populations the old state of affairs remains unaltered. The people are either unclad, or such garments as they do wear are of the most flimsy and insufficient kind, and altogether unsuited to the altered climate of the country produced by the effects of canal irrigation.

A great and good work is being done by the Educational Department in the encouragement of manly games and athletic exercises amongst the educated youth of the country—a genial task in which the eager response of their scholars is a safe guarantee of the best results to the health and vigour of that section of the rising generation. A no less important benefit might be conferred upon the people by the Medical Department, in impressing upon their patients the absolute necessity of providing for the efficient protection of their persons by means of suitable clothing. Whilst performing the duties of Sanitary Commissioner, I lost no opportunity of instilling this doctrine into the minds of all with whom I had to deal. There is no doubt that much good might be effected in this direction by the district dispensaries, if, together with the usual doling out of drugs, advice also was systematically given in regard to this particular.

The extraordinary changes that have taken place in the Punjab, in common with other parts of India, since the epoch of the Mutiny, and the transfer of the Government of the country to the Crown of England, and which are steadily progressing in all directions, may be truly said to have converted the aspect of the province into something very new. I will refer only to one or two, which are more directly of interest in connection with the subject of my remarks.

The great systems of canal irrigation which have now overspread the larger portion of the area of the province, from the Swat Canal, in the North-Western Trans-Indus Frontier, to the West Jumna Canal, in its South-Eastern border—whatever may be the benefits they have conferred upon the country—have undoubtedly produced some very serious evils; not the least of which is a prominently marked deterioration in the salubrity of the climate of the province generally. Formerly, the climate of the Punjab was characterised as hot, dry, and healthy. It is now on all hands observed to be increasingly chilly, damp, and unhealthy. This is, I believe correctly, attributed to the very greatly increased crop cultivation and growth of trees. Whilst in many extensive areas the humidity of the air is intensified by evaporation from the surface soil, which is either flooded from the canals for

purposes of irrigation, or is water-logged by obstructed drainage, or is saturated with subsoil moisture by percolation.

The consequence of this abnormal humidity of the air is, that the people in these tracts are exposed to all the unwholesome influences of a damp climate, under alternating seasons of high temperature and cold, of which they previously had no experience, and to the hygienic requirements of which they have not yet learned to adapt themselves. Moreover, it is found not unfrequently that some areas—not themselves traversed by canals, but lying adjacent to canal irrigated tracts—become injuriously affected by the moisture wafted over them from such sources.

Another of the innovations which in the Punjab has tended greatly to intensify the injurious effects of the altered climate of the province upon the health of the people is the extension of railways. For, apart from the obstruction caused to the natural drainage of the country in many parts by their embankments, and the evils to which this gives rise, the railways, whilst altering the travelling customs of the people, immensely increasing and multiplying their movements to and fro, and effecting many changes in their domestic habits, have at the same time exposed them to some serious dangers to health, and brought about an untold amount of sickness and mortality amongst them, owing to the faulty construction of the passenger cars provided for their accommodation, in respect to proper ventilation and protection from inclemencies of the weather. The third-class carriages—and they carry by far the largest portion of the passenger traffic—with their open barred windows and draughty compartments, which are habitually overcrowded to a dangerous extent, are perfect death-traps to hundreds of their unsuspecting occupants.

On numerous occasions of night travelling by railway, I have been kept awake by the cold damp draughts whistling through the roomy and well furnished first-class carriages, notwithstanding that I was well wrapped in furs and warm rugs. On such occasions my attention has been frequently aroused by the crying and moaning of children and other passengers in the third-class carriages. On several occasions I have stepped out at different stations *en route* to ascertain the cause of the sounds of suffering and distress, and therefore speak as an eye-witness of what I describe. The passengers were very lightly clad in the thin cotton garments of their usual attire, and but few were provided with additional wraps. Infants and young children, in a state of almost complete nudity, were carried under the arm or clung to their mother's bare body, with no other protection from the cold than the thin sheet covering the woman's shoulders. The trains usually travel at the rate of from 15 to 20 miles an hour, and now and again across tracts of country the air of which is more or less loaded with raw, heavy, cold, night moisture.

I remember an occurrence I witnessed one chilly autumn night at Julandhar Station, when a middle-aged man was so numbed by the cold that, as he alighted from the carriage, he fell down on the platform, and though repeatedly propped up by his companions, his legs refused their support till after he was dragged aside and shampooed for some minutes. At almost every station were found numbers of people crouched on the bare pavements, with little or no shelter, waiting for their trains. After this experience I could easily account for much of the mortality recorded under the headings "Fever" and "Bowel complaints;" for, by subsequent enquiry, I satisfied myself—from the histories of some fatal cases of pneumonia and dysentery occurring at Ludhiana and Gurdaspur—that many of the deaths recorded in towns and villages under the headings "Fever" and "Bowel complaints;" were due to acute inflammatory diseases, contracted in a railway journey, under conditions such as I have faintly sketched.

I have alluded to this source of mortality here, because it seems to me to be directly connected with the deterioration effected in the climate of the Punjab by the system of canal irrigation; and more especially because it is one capable of easy remedy—at least, to some considerable extent—by the provision of properly sheltered accommodation for this most numerous class of the travelling public. Unfortunately, it is not so easy a matter to remedy the unwholesome changes in the climate of the country, which have been produced by the co-operation of the several causes previously referred to as the results of canal irrigation. Much may be done, however, towards mitigating the suffering caused by sickness attributable to this deterioration of climate, and with, perhaps, a proportionate reduction of the very high death-rate obtaining in many parts of the province.

The class of diseases which claims the bulk of the mortality registered in the Punjab—and

I believe in the other provinces of India as well—is denominated "Fevers" in the official statistics. But the term, as I have said in a previous passage, includes death from almost all acute inflammatory affections which are attended by well-marked febrile symptoms, as well as those due to true fever, whether of malarious or specific origin. So that the mortality recorded under that heading affords no true index to the character of the climate of the country in which it occurs; more especially as regards the specific fevers—typhus, and relapsing or famine fever.

Next to "Fevers," the largest proportion of the total mortality is classed under the heading "All other causes," as before described. This category includes all the deaths registered other than those classed under the headings "Cholera," "Small-pox," "Fevers," "Bowel-complaints," and "Injuries;" and among them are contained many deaths resulting from the sequels of fevers, such as dropsy, enlarged spleen, liver and kidney diseases, and rheumatic affections.

The great bulk of the mortality annually registered is the result, however, of fever and febrile affections of various kinds, but mostly of the fevers and their sequelæ, which are due to the action of malaria; that is, of unwholesome air characterised by an unusual amount of humidity derived from evaporation of moisture in the soil—whether with or without deleterious exhalations from decomposing organic remains—and subject to more or less sudden and great variations of temperature in the course of the twenty-four hours, through the influence of the sun, in the several seasons.

The action of malaria is, I believe, by the operation of chills upon the surface of the body exposed to their influence in an insufficiently protected state. By the term "chill" is meant not any degree of actual cold, but a sudden reduction of temperature in an atmosphere charged with an unusual amount of humidity, and at a more or less high degree of temperature, whether the change be perceptible or not at the time of its occurence. The chill acts by constricting the minute capillary blood-vessels of the skin, and thus more or less seriously obstructing the normal functions performed by that important organ in the processes of exhalation and secretion.

Such hindrance in the natural offices performed by the skin in the functional economy of the system may, or may not, be compensated by the vicarious action of one or more of the other great secretory organs of the body. Generally speaking, an occasional or casual chill produces no more than a slight and temporary derangement, the discomfort resulting from which is soon recovered from, by some other vicariously-acting organ performing as an extra task the work suspended in the skin. For instance, a check to the action of the skin by chill, such as occurs by temporary exposure to a draught whilst in an unprotected state of the body, and which may make itself felt by no more than a slight headache, or feeling of indisposition, is often quickly worked off under active exertion or exercise, by an increased fulness and frequency of respiration, without any further inconvenience to the subject.

If the chill be severe, and more prolonged, as occurs in sudden transition to a cooler and damper climate—for example, in proceeding from the plains to the hills, without due precaution in the matter of clothing—the arrest of action in the skin may be compensated either by greater activity of secretion in the intestinal mucous membrane, when a brisk diarrhœa removes from the system what ought to have been discharged through the skin; or by an increased activity of the kidneys, when a freer flow of urine carries off what could not find exit through the skin; or else by an attack of vomiting, when the same end is attained by a copious ejection of fluids from the stomach. These are the ordinary ways in which the derangement produced by casual chills is commonly rectified by the natural efforts of the healthy body.

But when the action of chill is not merely a casual or occasional occurrence, when, on the contrary, it is a matter of frequent and everyday incidence—as in localities where the climate is either habitually, or, at certain seasons, unusually damp through an atmosphere overcharged with humidity derived from the evaporation of moisture in the soil—then the case is different, and assumes a graver aspect.

In such localities, some robust and healthy constitutions are by habitude, aided by comfortable living and frequent changes to purer air, enabled to become as it were acclimatised, and their bodies adapt themselves to the circumstances of the situation. This, however, is not the case with the vast majority of the inhabitants in the tracts of country characterised by a climate possessing the unwholesome qualities referred to. In their case poverty, helplessness, and ignorance combined deprive them of any chance of ever

becoming acclimatised; the natural efforts of the body to maintain itself in health against the unwholesome influences continually acting upon it, receive no extraneous aid, and the system unsupported soon succumbs to the superior forces arrayed against it.

Without entering into pathological details, it may be said in general terms that chill, operating frequently and during long continued periods, produces derangements in the functional processes of the system which are no longer recovered from after a merely temporary indisposition, by the compensating action of other organs coming naturally to the rescue of the skin. For these vicariously-acting organs, by the repeated demands upon their good offices, become at length themselves overtaxed and disorganised, and the consequence is that the body becomes more or less seriously damaged by this impairment of power in the great eliminating viscera. The diseased conditions thus induced so enfeeble the vital processes that the body no longer possesses the ability to retain its natural heat, which is constantly drawn off by a rapidly conducting damp atmosphere. This defective power of recuperation to meet this drain and restore the tone of the system gradually saps the strength of the constitution, and renders the body peculiarly prone to the assaults of active disease.

In this state matters may endure for a time, longer or shorter as the case may be, and life may continue in a sickly and enfeebled frame, till at last it is suddenly extinguished by some acute inflammation; or it may linger on till it finally expires through inability to exist in a too much broken-down machine. The state of things thus briefly indicated is familiar to those who have any experience of the class of diseases prevalent amongst the inhabitants of marshy or waterlogged tracts of country; whilst the inferior physique of the people generally in such districts is a matter of notoriety, and plainly perceptible to the most casual observer.

Happily, however, it is not everywhere that these injurious effects of a climate, rendered unwholesome by the causes referred to, are manifested in so extensive and serious a manner. Much depends upon the surroundings and actual conditions of life amongst the people. Where poverty and overcrowding are added to such unwholesomeness of climate, there this class of diseases is found in intensity of prevalence and development, under very various forms, which take their several distinctive features from the derangement produced by the disorganisation of one or other of the great eliminating viscera. But they are all referable to the effects of chill in the first instance, as the prime factor in the diseased conditions which other accessary causes have modified and complicated.

This is well illustrated in the transition from agues and intermittents to remittents and bilious or yellow fevers; or in the transition from simple chills or febrile colds to what are now commonly called enteric or typhoid fevers. During the early years of my service in India this last-named disease was always called common continued fever, was not considered contagious, and was attributed to the effects of chill; of late years, however, one never hears of the old familiar common continued fever. The disease formerly known by that name is now called enteric fever, is considered contagious, and is attributed to sewage poison. But on what ground these changes have been made I have not been able to ascertain.

During later years cases of enteric fever, and of diarrhœa too, occurring at Simla used to be attributed to sewage pollution of the spring water, and it was confidently predicted that as soon as the station was provided with a pure and properly protected water supply, we should have no more enteric fever and no more diarrhœa. Not that the spring water was really polluted by sewage matters, for it was drawn at the spring-head where it issued on the surface. The pollution, if any, must have filtered through a deep layer of shale; whilst the probability of any excremetitious or sewage matter finding its way by percolation into the spring reservoir was not very apparent, since the heavy rainfall effectually drained off all surface impurities down the steep slopes of the hill. Meanwhile, whatever impurities there were, they were certainly not composed, to any appreciable extent at least, of excrement or sewage; for Simla is one of the best scavenged towns in the world. The surface drainage is naturally prompt and efficient, owing to the steep slopes of the hill, whilst the whole of the ordure—I am speaking of the time prior to the introduction of the new sewage system—was removed in air-tight buckets, and carted away every twenty-four hours several miles out of the station down the hill, by a strong body of scavengers specially organised for the duty.

Well, be this as it may, Simla has now for six or seven years past had a properly protected water supply, brought in mains from

springs on a carefully preserved hillside fourteen miles distant, and stored in covered reservoirs, from which it is distributed in pipes over the station; moreover, the water has been pronounced by experts to be pure and of first-rate quality. But have enteric fever and diarrhœa disappeared as predicted? Not at all. If, anything, they are of more frequent occurrence than before. One of the most severe outbreaks of epidemic diarrhœa that has visited Simla within my knowledge occurred in the second year after the introduction of the new system of water supply; whilst cases of enteric fever occur there more frequently now than when the station was dependent on its own springs only.

Since the new water supply is above suspicion, it is now the milk supplied to the station that brings the poison; being nefariously diluted with the village water, which it is assumed is polluted with sewage matter; and consequently the native purveyors of milk experience some hard half-hours with the doctors whenever a fresh case of enteric fever occurs. Some few years ago, in 1883 I think it was, a very high official of the Supreme Government of India chanced to suffer an attack of enteric fever, happily not a very severe one. But it puzzled the doctors to account for its cause. The water-supply was from the new works, and above suspicion; the milk consumed by the household was from their own cows, stalled on the premises; the cook was a French *chef*, with a justly high reputation for his skill in the science; the season was not a particularly unhealthy one. Under these circumstances it was surmised that perhaps the case was not one of enteric fever, after all. Perhaps it was not. I believe it was, and from what I casually heard at the time, could trace the attack to the consequences of a succession of chills contracted at dinner parties and evening entertainments being neglected, through press of office-work, till the first trifling symptoms of functional derangement becoming aggravated, culminated in an attack of continued fever, with enteric symptoms, or catarrhal affection of the intestinal mucous membrane.

On another occasion, subsequent to the case just mentioned, I had to investigate the circumstances attending a succession of six or seven cases of enteric fever during a period of as many months amongst the children in the Lawrence Military Asylum at Sanawar, and which were attributed to sewage poison in the milk supplied to the Institution. The result of my inquiry was, that they were each and all attributable to chills contracted in the dormitories, or corridors and passages, and neglected in the incipient stages. Besides these, and numerous other instances I could cite as occurring among European soldiers, and native prisoners, I have, in my own family, seen lightly-treated or neglected chills pass on into continued fever, developing, in one case, enteric symptoms, and in another, bronchial.

The forms of malady developed from the effect of chill upon the action of the skin present themselves under a great variety of symptoms and pathological features, according to the different organs more directly or seriously implicated in the after-consequences, as these may happen to be determined by accidental circumstances. Sometimes, agues and intermittents are the prevailing forms; at others, remittent and yellow fevers. Sometimes, bowel complaints, diarrhœa, and dysentery are the prevailing forms; at others, lung affections, pluro-pneumonia, and bronchial catarrh. In some seasons, cholera in epidemic form prevails; in others, influenza; and not unfrequently, as occurs in unfavourable seasons of drought, and rainfall following in sudden succession, two or more of these principal types may run an epidemic course together.

But in all these instances, chill is the prime cause of the commencing sickness, whatever may be the state or predisposition of the sufferers from other circumstances of an unfavourable nature, such as deficient food, defective clothing and housing, undue exposure and fatigue, and so forth.

In this view of the case, taking the effects of chill upon the action of the skin as the prime cause of those derangements in the functional processes of the body which constitute the pathological features of the various diseases classed under the head of fevers, as before explained, we may now inquire what is the course to be adopted in order to avert or to counteract the effects of chill.

The conditions of climate that I have mentioned as resulting from the introduction of canal irrigation may be looked on as established facts that cannot now be well altered. They may be considered as of a permanent kind, and, moreover, beyond modification in respect to the changes already effected in the character of the climate. In fact, we have the chills as a permanent legacy, and must now make the best we can of them. In the future, perhaps, at some indefinite period, probably distant, drainage works on an extensive and

comprehensive scale may somewhat relieve the soil of its superfluous moisture, and maintain it in a comparatively wholesome condition.

Meanwhile, without waiting for the advent of this good time coming, much may be done at once towards mitigating the injurious effects of canal irrigation upon the health of the people, by controlling within narrow bounds the amount of water spread over the surface of the soil. This can be effected by means of stringent regulations limiting the supply from the canals to the lowest amount actually necessary for irrigation. Any measure of this kind, however, would not affect the evils of a water-logged soil, the result either of percolation through porous strata or else of obstructed flow of the subsoil drainage; and in the tracts of country where these soils exist we must be prepared to find a persistent prevalence of chills, and of the diseases which they tend to produce.

So that it is the chill itself to which must be directed our attention, if we would look for any real improvement in the health of the people, or any reduction in the high death-rates obtaining amongst them. I have already referred to chill acting upon the skin as the prime cause of those functional derangements, which develop into the various diseased conditions, the resulting mortality from which is classed under the head of "Fevers" in the official returns, and I believe that it is quite practicable to control the prevalence, or even, to a considerable extent, to prevent the occurrence of this class of diseases. For, though the conditions of climate and soil inducing the diseases referred to are more or less altogether beyond our powers of control, we yet have the means, if properly applied, of protecting the body from these injurious influences of weather by means of suitable clothing and efficient housing. These are the requisites to the provision of which the efforts of the people must be directed, in order to mitigate the injurious effects upon their health which have been produced by the unwholesome changes that have been brought about in the climate of their country by the results and consequences of our system of canal irrigation.

Medicine affords but little aid in this direction, since it deals with the case only after the mischief is done; and at best the use of drugs is but a palliative measure, and of very doubtful efficacy. Our motto should be, "Prevention is better than cure," and to the most direct and surest means of attaining this end should our attention be devoted.

In our medical system, as taught to the natives, and carried out as a department of the Government Service through their agency—though in surgery, as distinct from medicine, it has conferred a really great blessing, and supplied a want the country itself was quite incapable of meeting—too little attention is given to the importance of regimen and diet as aids in the treatment of disease. And it is, I believe, largely owing to this fact that the district hospitals and dispensaries we have established all over the country have practically failed to acquire the confidence of the people, or to enlist their cordial support. These institutions might be made much more useful than they have hitherto proved, if the natives were taken more into our counsel in details of their management, and if instead of serving, as is the case to a large extent, merely as depôts for the doling out of medicines, in the efficacy of which none of the intelligent classes place any confidence—they were used as centres for the dissemination of information and advice on the more important details of domestic hygiene, and precautions relating to the protection of the person from the injurious effects of unfavourable weather influences, by means of proper diet, suitable clothing, and efficient housing.

Through the initiation of the Sanitary Department much good has been effected in this direction by means of the native medical journals, which of recent years have been established by private enterprise in the various provinces of India, and this method of disseminating useful information on these important subjects amongst the people is deserving of encouragement and guidance.

Sanitation affords a surer and more precise means of mitigating, if not of preventing, the evils we are now considering than can be hoped for from medicine, but, unfortunately, this department, in the Punjab at least, has not effected as much as might have been done to improve the sanitary condition of the towns and larger villages. This is owing to several causes, but chiefly to the want of local funds and the absence of Government aid, and especially to the fact that the projects proposed are of too expensive a character, besides being unsuited to the immediate requirements of the case. The consequence is that much of the work done is of a piecemeal and patchwork description, and of really no practical or efficient utility.

I do not mean to say that the various great measures of public sanitation which during the

past twenty years or more have been carried out, and are in course of active prosecution in all parts of India—despite the many faults in matters of detail which have been disclosed by experience—have done no good. On the contrary, they may be well enough in their way, and no doubt contribute something towards placing the general sanitary surroundings of some few places on an improved footing. But what I do say is that the work of sanitation in India has not been carried out on the extensive, practical, and continuous system which the requirements of the country urgently demand. Little or nothing has been done in the matter of providing the majority of the towns and larger villages in the Punjab with an efficient sewerage and water supply; and yet there are few towns in the province, apart from the larger cities, in which both these urgent wants cannot be immediately provided by inexpensive projects, suited to the requirements of the situations, and capable of being carried out and managed by native science and work. For instance, almost every town has some system of internal sewerage by means of open surface gutters and drains, but the great fault in all is that these drains discharge at several different spots round the immediate town precincts, and thus surround the inhabited area with a ring of so many pools of stagnant, festering liquid filth. The remedy for this is an outside circular intercepting sewer or drain, to conduct the sewage away from the town in the direction of the natural drainage of the surface, and the work could be done at once at no great cost. And so with respect to the water supply.

Many of the towns and larger villages could be easily provided with a wholesome water supply at a moderate cost, by means of very simple works, which could be carried out and managed entirely by the native municipal authorities. In the case of many towns the water might be brought in an open cutting from some neighbouring stream or canal, and purified by passing through, first a series of precipitation tanks, and then through a series of filter beds; with arrangements for the stream being led from one to the other in each series, so as to admit of their being periodically shut off in succession, for purposes of cleansing. And from the filter beds the water could be passed into covered masonry reservoirs, whence it could be drawn off as required, through taps and stopcocks; and at the same time supplies could be stored in open tanks for use during the times when the stream is temporarily stopped, owing to closure of the canal for repairs, or other cause.

Such simple arrangements for the immediate provision of effective sewerage and a good water supply do not seem to have found favour with the European authorities, and the consequence is that little or nothing has been effected in these directions towards improving the sanitary requirements of the mass of the towns in the province. Even with respect to the great projects on the European system of sewerage, and water supply, which have been planned and estimated for the larger cities, and which have been submitted to the consideration of the Government repeatedly during the past sixteen or twenty years, little or nothing has been done of a practical kind, except in one or two instances, such as Simla and Lahore, where the interests of a large European community have stimulated the authorities into action for their personal benefit. I cannot cite a single instance in which such works have been carried out in the interests of the natives. On the contrary, I can cite some instances, such as Peshawar, Mean Mir, Ambala, &c., in which the military stations have been provided with costly systems of water supply, whilst the adjoining native cities have been left in their old neglected condition.

Whatever may be the explanation of these facts, it appears to me that greater progress would have been made in the sanitary improvement of the mass of the towns and villages, if the native authorities were more freely consulted, and our plans and projects were of a kind more suited to their immediate requirements; but, above all, if our interest in the welfare of the people were shown in a more practical and sympthetic manner. Hitherto, the work of sanitation amongst the natives has been carried on under many disadvantages, from the causes just alluded to. Nevertheless, despite the difficulties the Department has had to contend against, much solid good has been effected throughout the province generally, in matters of scavenging, street-paving, surface-drainage, and the control of injurious and unwholesome trades, and so forth.

But all these, though good in their several ways, as substantial aids towards the improvement of the sanitary conditions surrounding the people in their places of habitation, are not the measures, even if they were carried out in the perfection found in our military stations, which are more immediately required for the protection of the people from the direct action of weather and climatic in-

fluences, nor does this object come within the scope of their design. The protection of the person against injurious effects of weather influences is necessarily a matter of individual interest and responsibility, and the advantages of such protection are so obvious, that it can be attributed to ignorance, coupled, perhaps, with poverty or helplessness, only that no action has hitherto been taken in this direction as a general popular movement.

The natural predilection for old-established customs, and the prejudice against innovations introduced and suggested by alien rulers, probably play a not inconsiderable part in the apathy of the people in adapting themselves to the altered conditions of their surroundings, which have been brought about by our rapidly increasing and wide spread canal and railway systems. But the people are intelligent, and by no means indifferent to their personal welfare, so that, if the matter were properly put before them, there is little fear of backwardness on their part in adopting such means as are available to them for providing themselves with efficient protection against climatic inclemencies by suitable clothing and housing.

In the course of my sanitary work amongst the people, I have often spoken to large assemblies of townsmen and villagers on this subject, and discussed the details with their leading men. In the districts affected by canal irrigation, the people everywhere observe, and complain of, the deterioration that has taken place in the climate of their habitations, and commonly declare that greatly increased sickness had settled down amongst them since the introduction of canal irrigation, and this not only amongst the people but amongst their cattle as well.

The only true remedy, as far as I can see, that affords any hope of an appreciable amelioration in the sickly condition of the people, produced and aggravated by the unwholesome climatic changes referred to, is the general adoption of warm clothing—especially for infants and growing children—and of better house warming by a more general use of fires. But the clothing is by far the most important requisite, and should be of woollen or flannel material in preference to any other, as being the best adapted to protect the body against sudden alterations of temperature, and the chills resulting thereby, as well as being the best suited to retain its natural heat, and maintain its surface at an equable temperature at all seasons and in all weathers.

The remedy for the evils we are considering is not to be found in the mere use of medicines, nor in the prosecuting of these measures of general sanitation, to which our efforts have been directed for several years past. For mere stomach medication—however useful it may be in its way—is but an unreliable and palliative resource at the best. Whilst sanitary improvements in the local conditions of population centres, though of great benefit in themselves as factors conducive to good health, do not afford the protection required by the individnal against the effects of unwholesome weather influences. Such protection is to be obtained only by careful provision of the requisites necessary for placing the individual in a position to cope fairly with the vicissitudes of weather and climate to which the body is exposed in the ordinary course of daily life.

These requisites are suitable clothing, wholesome food, and efficient housing. But of these the first is most important, and it is the one most needing attention, if only for the reason that it is the one most generally neglected. The body protected by suitable clothing retains its natural heat, the presence of which—whilst at once the source and sign of good health—enables it to resist and overcome the natural consequence of exposure to sudden and unusual changes in the temperature and humidity of the air. This sort of protection, then, is what must be provided if we would look for any amelioration in the health of the people, who are now suffering from the injurious effects of a climate rendered unwholesome by our systems of canal irrigation and their consequences.

The next requisite in the order of mention—and it is of hardly less importance than that just noticed—is wholesome food, for without proper nourishment the body cannot flourish in health. In the Punjab, wheat, oil, and lentils constitute the staple food of the people, and their production has enormously increased with the development of our canal systems. But this increase of production has not been attended with a cheapening of prices. On the contrary, these chief articles of food are about four times dearer now than they were previously to the establishment of our rule. This is owing to the facilities afforded by railway carriage having given rise to an export trade in cereals, oil-seeds, and lentils, by which not only is the surplus produce carried out of the country, but the granaries of the country itself are reduced to a condition of emptiness. As an indication of the rapid

growth and dimensions of this export trade in the food supplies of the people, I may quote from the "Agricultural Report" of the *Morning Post*, of the 25th April, the figures showing the total exports of wheat only from India to all other countries, for the seven years from 1880 to 1887. They are stated to be taken from a note appended to a second general memorandum on the prospects of the wheat crop for the current season, issued by the Revenue and Agricultural Department of the Government of India, and represent the shipments from the seaports of Calcutta, Bombay, Kurachi, Madras, and Rangoon. The figures for each year are given as follows (the year extending from April 1 to March 31):—

Year.	Cwt.
1880-81	7,444,375
1881-82	19,863,520
1882-83	14,144,407
1883-84	20,956,495
1884-85	15,831,754
1885-86	21,060,519
1886-87	22,263,320

The export of rape, mustard, and sesame—the principal oil seeds—and of lentils, is also very large from the Punjab. The consequence is that the mass of the labouring population, instead of deriving any benefit from the vastly increased production of food in their country, are driven to resort largely to maize and the inferior millets in their cravings for a stomach-full, and these they consume mostly either parched or boiled in water. I have on several occasions, when moving about amongst the people in seasons of epidemic sickness, found scarcity of food—even of the poor sort mentioned—a principal cause of their ready suscepibility to the morbific influences prevaling, and the greatest evil of the many co-operating at such times to aggravate their miserable condition.

Regarding the other requisite — efficient housing—little need be said. The deficiencies in this respect, though great enough, are not of so pressing and important a nature as the two I have briefly alluded to. The main points to be attended to in this direction are good ventilation and efficient warming to prevent dampness of the floors and walls. But nothing is to be hoped for of a practical kind till the people are better instructed and less poverty-stricken.

Such is the state of the case, and the question of a remedy is the concern more of political econom than of medical relief or sanitary improvement. Be this as it may, however, the matter is one of most serious importance; for though the voice of the suffering millions is not heard, their high death-rates and deteriorated physique are eloquent.

DISCUSSION.

The CHAIRMAN, in inviting discussion and criticism on this valuable paper, said he was rather disappointed to find that his valued and scientific friend had taken such an apparently pessimistic view. He did not differ with him as to the diffusion of disease or the remedies, but he thought it possible that having been so constantly brought into contact with evils, Dr. Bellew had somewhat over-estimated them. It might be that he only wished to treat one aspect of the story, but he hoped the audience would not go away with the impression that the sanitary officers and other Europeans in India were indifferent to the condition of the people. There was an immense deal to be said on the subject of irrigation, both for and against, but it was not to be condemned because there were evils attending it. It was in fact absolutely essential to enormous areas in India where there was hardly any rainfall, where without it there could be no cultivation, and where in consequence there could be only a very sparse and ill-fed population. There were 6,500,000 acres rendered productive and fertile by means of irrigation, and he did not like, therefore, to hear only the evils spoken of without calling attention to the inestimable benefits it had conferred on the country.

Surgeon-Major INCE, M.D., said there was a popular idea that malaria and ague were the effects of canal irrigation, but he took the liberty of questioning it altogether. At Peshâwar and Ludiána there were no canals, but the amount of fever at Ludiána had obtained on one occasion a world-wide reputation, and if irrigation were the cause of fever, where did it come from there? The medical men of the present day rushed to conclusions in what he considered a most dangerous manner. He defied any sanitarian to prove, with any reasonable degree of logical accuracy, that a single disease arose from so-called unsanitary conditions. A short time ago there was an outbreak of scarlet fever, which was put down as a consequence of disease amongst the cows in the neighbourhood of Hendon, but when the matter was more calmly investigated, the theory was found to be groundless. Immense inconvenience, and expense, and annoyance were inflicted on the public in the endeavour to obtain pure air and water, but such things were perfectly unattainable. Wholesome air is easily and quickly secured by the most ordinary attention to ventilation. Happily, too, water was a thing which in the course of nature purified itself; it was subject to the universal law of gravitation, and water so purified he preferred to that which had been passed through a filter, which often

did more harm than good. To return to the more immediate subject of the paper, he maintained that some of the most severe and fatal forms of fever occurred where there were no canals.

Dr. BELLEW said he would at once reply to the point, first, as to occurrence of fever at Peshawur and Ludiana. Both those places were unhealthy, from the very cause which rendered other places unhealthy from canal irrigation. At Ludiana there was the Budhai nullah, which was obstructed about a mile and a half from the station, so that the town was nearly half surrounded by stagnant water, and a great part of its circumference on that side was constantly in the state of a marsh. With regard to Peshawur, similar conditions arose from the co-influence of the two rivers, the Kabul and the Swat; they received periodically the melted snows from the Afghan hills, the narrow outlet at Attock would not allow their waters to pass, and they were thrown back on the channel, overflowed the banks, and turned the surrounding country into a swamp; further, from the depression of the valley at this part, the soil was always supersaturated with moisture. When he had charge of Peshawur jail, he measured and weighed the prisoners, with a view of ascertaining their physical condition, and he found that both in height and breadth of chest the difference in those from the valley and those from the higher ground from the foot of the hills was most surprising. Those from the centre of the valley were like Bengalees, they carried the impress of malaria in their faces.

Mr. T. H. THORNTON, C.S.I., while recognising the great value of Dr. Bellew's paper as a record of personal experience and observation, agreed with the Chairman in thinking that its tone was unnecessarily pessismist. From reading it one would gather that the Punjab was a land of poverty and wretchedness, whereas the contrary was the case. There were poor people there as in England, but the mass of the population was singularly prosperous, and included some of the finest races in India. In proof of its growing prosperity, he would mention that in 1859, when he was Secretary to the Financial Commissioner, the average selling price of agricultural land was four years' purchase of the land-tax—it was now nearly thirty years' purchase. Meanwhile population and cultivation had vastly increased, and so had imports and exports. The people were better clothed, and the standard of living had sensibly improved; while, owing to the extensive sub-division of the land, the agricultural prosperity was very widely diffused. Then taxation pressed far less heavily than before. In Sikh times the Government took from the land all that it could get—that is to say, half the produce, and more. The British Government of the Punjab professes to take the cash equivalent of only one-sixth of the gross produce, while in reality it takes a good deal less, and as the settlements of land-tax are made for periods of 20 and 30 years, the incidence of the tax decreases with the extension of cultivation, and in some cases is no more than one-twentieth or one-thirtieth of the produce. Dr. Bellew went on to say that the natives of Kashmir, Rajputana, and Afghanistan, struck him as better clothed, and less poverty-stricken, than our own subjects. He (Mr. Thornton) had not seen much of Rajputana, or Afghanistan, but he had been to Kashmir, and his impressions were quite the reverse of Dr. Bellew's, for he thought he never saw a more miserably poverty-stricken race than the Kashmir villagers; and well they might be, for the Kashmir Government carried on the old Sikh system of taking half the produce. Again, Dr. Bellew, while rightly insisting on the importance of freely consulting the people in reference to sanitary measures, left it to be inferred that they are not so consulted at the present time, whereas there is no part of India where the people are so freely and fully associated with the officers of Government in administrative matters as in the Punjab. There are upwards of 200 municipalities, in which the town councils are composed almost entirely of natives of the country, while every district has its county council of rural notables, and the district medical officer is an *ex-officio* member of these councils. Hospitals and dispensaries, generally in charge of native medical officers, are scattered over the province, and resorted to by yearly-increasing numbers of patients, male and female. With regard to the remedy proposed for the unhealthiness resulting from extended canal irrigation, Dr. Bellew feared, and with justice, that drainage works will take long to execute, and urged that, meanwhile, measures should be taken to induce the natives to wear woollen vests next the skin. No doubt this would be an excellent move, if possible; and it might be mentioned, in support of Dr. Bellew's opinion, that, according to Niebuhr, the depopulation of the Campagna from malaria was the result of the introduction into Europe of cotton in lieu of wool as the material for underclothing. But he (Mr. Thornton) feared it would take a long time to teach the native population to change their habits. But something could be done in both directions. In the matter of drainage something had been done already, for he was informed that, owing to some recently-executed drainage works, the station of Peshâwar, from being one of the most fever-stricken of stations, had become one of the most healthy; and if Dr. Bellew's successors in the office of Sanitary Commissioner would follow his example of holding meetings at towns and villages in the Province, explaining the principles of sanitation, and giving practical advice to the people as to the best way of meeting the change of climate resulting from irrigation, much good might be done.

Mr. MARTIN WOOD said he was rather disappointed at seeing the title of this paper so soon after a similar one by Mr. Thornton, and feared it might lead some people to think that irrigation was little more than an unmitigated evil. But the Chairman had already met and disposed of such

misapprehension, and had shown that the drawbacks were but of minor importance compared with the vast benefits conferred by irrigation. Mr. Thornton had spoken of the vast increase in production, but the question still remained what part of that produce remained with the people to be enjoyed by them? Dr. Bellew said he should not attempt to substantiate his statements by statistics, one reason being that the deaths were not classified with sufficient accuracy, which was to be regretted, seeing how much these statistics were relied on. The Chairman himself must have been surprised at this wholesale disparagement of Indian mortuary statistics, for he knew well how largely the Army Sanitary Commission depended on those statistics, and framed orders upon them. As to the subject before them, it was rather difficult to judge between the pessimism of Dr. Bellew and the optimism of Mr. Thornton; but he thought that Dr. Bellew had treated the matter in a scientific way, as he spoke of what he had actually observed. It might, however, be somewhat begging the question to attribute the unfavourable condition of the people to malaria, and the malaria to the canals, because elsewhere Dr. Bellew gave the impression that these diseases of the fever class were attributable, in great measure, to the poverty-stricken condition of the people. Mr. Thornton seemed to think the evils would be remedied by telling the people to put on more clothes; but probably the people in the Punjab felt heat and cold the same as we did, and those who could do so would clothe themselves, not only with cotton but with woollen, if they could get clothing; so that, after all, it came back to the question of their industrial condition, which was too large a one to go into then. At first sight there seemed an utter inconsistency between such an enormous increase in production, and people in such a poverty-stricken condition; but it might be that these changes had arisen from a large export of the produce of the country in connection with the revenue demands. Mr. Thornton had contrasted the old-fashioned demands of the Sikhs and lighter taxation under English rule; but he believed that under the Sikhs the revenue was taken in kind, whilst ours had to be paid in money, and this would account for a good deal.

Mr. Thornton said the Sikh revenue was not entirely taken in kind; a great deal was paid in cash.

Mr. Martin Wood said at any rate the revenue then remained in the country, whilst that now taken did not. Dr. Bellew had referred incidentally to the superior condition of the people in certain Native States, and there the revenue, whatever it was, remained in the province. He was rather disappointed at so few general suggestions being thrown out as to the remedies for the evils described. Drainage, of course, should form part of every system of irrigation where it was needed, and its omission was inexcusable. At the previous meeting he had asked if there were not certain trees which were very valuable in absorbing moisture, and Mr. Thornton quoted from some one who had travelled in the Punjab that wherever a village was found exceptionally healthy it had a belt of trees round it. If this were so, there was at once a practical remedy, which should be carried out either by the Forest or Public Works Department. The paper bore testimony to the life-long acquaintance of the author with the people, and he was satisfied that an enormous amount of good would be done if we could manage through the vernacular, as Dr. Bellew had done, to get nearer to the people, and invoke and utilise their assistance in public work of all kinds.

Sir Owen Burne said he attached the greatest value to these papers and discussions, and he had reason to know that such papers had a wide circulation in India, and were most useful to the authorities. Their distinguished Chairman had reminded them that irrigation was a great blessing to India, and though much might be said about the evils attendant upon it, nothing would convince him that it was not one of the greatest blessings. At the same time there had, no doubt, been many mistakes made, and engineers had often constructed canals without paying sufficient attention to drainage works; but there were, he believed, drainage works to some extent in the Punjab, and they were not liked by the people, because cattle and human beings too often fell into them. This paper was a valuable supplement to the one recently read by Mr. Thornton, and all the reader of the paper had said pointed more and more to the value of a sanitary commissioner being appointed to each canal district. If those officers paid attention both to drainage and to the clothing of the people, much good would be done. The value of fires had been alluded to, and he believed that in the Pontine marshes, not only did the people keep fires burning outside their cottages, but men lived and slept in the very centre of that malarious district without harm by the side of a good fire.

The Chairman, in moving a vote of thanks to Dr. Bellew, said he did not intend in his previous remarks to find any fault with him; he had known him by reputation for many years, and highly appreciated his many public services, but it appeared to him that he had taken a somewhat pessimistic view, and that his paper would convey a somewhat darker impression than he had intended. Whilst fully admitting the evils which might and did attend irrigation improperly applied, the benefits accruing from it were quite beyond dispute. Few people realised the immense size of India, which covered an area equal in size to the whole of Europe, excluding Russia; and in that vast continent there were immense tracts which would be perfectly sterile without irrigation, and the evils which had attended

it might, under the direction and advice of such men as Dr. Bellew, be entirely removed. A system was not to be condemned because there were some evils connected with it. There were parts, such as the great desert tracts of Scinde, where there was practically no rainfall, and which without irrigation must be sterile and depopulated. There were other parts, as in the great Gangetic Valley, where the rainfall was not more than thirty or forty inches annually, where they could get on without irrigation, but where it was very desirable to have it to supplement the deficiencies of the rainfall. In other parts the rainfall was superabundant, and, of course, it was not possible to make the distribution equal; but if ever a country owed much to irrigation it was India. It was not a new device, we were only continuing the system begun in past ages, built up both by the Hindoos and Mohammedans, though men like Cautley, Sir Arthur Cotton, Fyfe, and others had improved immensely upon the old system under which many of the canals were defectively constructed. There were now 12,750 miles of canals, not including the small ones, irrigating six and a half million acres, all of which would be otherwise almost wholly unproductive. He knew very well, for he had seen it, that there was much sickness produced. Their predecessors did not see it to the same extent, because in those days the northern parts were not irrigated, whilst in the south, and in the Deccan, the land was not so much affected by stagnant subsoil water. The whole secret of unhealthiness and high death-rate lay in stagnant subsoil water. This occasioned that condition which, by an expression of ignorance, was called malaria; this term had a sort of quasi-scientific sound, but they literally did not know what it meant. They could only say that it arose where there was heat, moisture, and decomposing organic matter, animal or vegetable; and there could be no doubt that those conditions prevailed where the country was imperfectly irrigated. The thirteenth annual report of the Sanitary Commission, for the year 1880, contained much information with regard to the prevalence of fever, and the influence of irrigation upon it. It dealt particularly with the great Terai valley lying at the foot of the Himalaya range, where the water ran down the sides of the hills and soaked into the soil. There were no great lakes to receive and store the water as there were at the foot of the Alps, but it penetrated the soil until it met with beds of impermeable clay, which made it surge up again in all the low-lying parts of the country, which thus became fertile, but at the same time malarious and unhealthy. The Doab, which was irrigated, was scarcely less unhealthy. In the year referred to there were 922,633 deaths, and 23 out of 29 were due to fever. As Dr. Bellew had pointed out, it must not be supposed that all these were cases of what would be called fever scientifically, but they included many other diseases which involved a rise in temperature. The classification was not perfect, but it was improving, and this general class of fever diseases was the great cause of the death-rate. Cholera, smallpox, and all the other diseases were nothing in comparison. In one year there were 71,546 deaths from cholera as against 987,222 from fever; and a large proportion of these were due to climatic causes, which might be expressed under the term malaria, and that arose distinctly from stagnant subsoil water. Dr. Ince had asked how there could be fever in Peshawur, where there was a dry arid soil. Some of the arid plains of Spain were very subject to fevers, as much as the swamps of Bengal. There were distinctive features in each case, but it was substantially the same disease. In the case of the great irrigation canals more water was used than was required, which was an engineering question, and no doubt it would be attended to when it was realised that this was a cause of disease, and it was quite time now that it was recognised. This over-irrigation not only caused disease, but also rendered the soil sterile, as it dissolved out of the earth the various saline matters, chiefly sodium and lime salts, which effloresced on the surface, and under the name *reh* did much damage. All this could be prevented by proper precautions. If only sufficient water for the growth of vegetation were supplied there would not be too much moisture in the atmosphere. A great part of the desert tract in the north-west of India was sterile because it had been deforested. There was evidence of ancient rivers which used to run to the sea, but had now disappeared in the sand, and that great cities formerly existed where there was now only a desert, and that was to a great extent because the trees had disappeared. He agreed with what Dr. Bellew had said as to better clothing, food, and lodging, and especially as to the value of wool. He constantly said that if he were asked to advise anyone going to a tropical climate, and were only allowed to tell him one thing, it would be to always wear flannel underclothing, so as to prevent chill. Chill was purely relative, for one felt chilled on going into an atmosphere which under other circumstances would be hot; it arose from the sudden transition from one temperature to another. But it was not only a question of clothing or of improving the railway carriages; the great thing was to educate the people, who were rather slow to learn. They were an ancient people, and did not readily adopt the ideas of foreigners. Not only precept but example was required, and if this were continued they were quite intelligent enough to profit by it. He was very glad to hear Mr. Thornton's testimony that the people were improving and increasing in wealth, and his own impression was, that Dr. Bellew had seen them at their worst. He was also glad to hear, from Sir Owen Burne, that the experience of those who had made these matters the study of their life, and who could only have one object, that of doing good, was listened to; and, as far as he could see, there was a tendency not only to listen to but to act on the

advice so given. At the same time, seeing that nearly all the recommendations made were costly, and were, many of them, theoretical, and founded on opinion only, they could not expect the Government to rush hurriedly into the expenditure of large sums in the application of theories which were still *sub judice*.

The vote of thanks having been passed unanimously,

Dr. BELLEW, in reply, said it was no part of his object to show the benefits of canals; they were constructed because of the advantages they would confer, which were well understood; his object was to point out the evils which attended them, in order that they might be remedied. When Sir Donald Macleod came to Peshawur, he took him round the city and showed him all the fine bazaars, but he said he wanted to see all the slums and bad places. It was no part of his business to praise the Government; if you wanted any improvement you must point out the evils and insist upon them. It was no use to be perpetually dwelling upon all the fine things which had been done, and praising the men who had done them; he took all that for granted. If you wanted to find out what still remained to be done, you must go to the natives and see what their view of the case was. He had endeavoured to convey the impression made on his mind from very intimate converse with the natives of all classes, amongst whom he had moved, he believed more than any other official he had ever met. He hoped he was no less enthusiastic in his loyalty to the Government than other officers, but that was no reason why he should not point out the aspects he had observed. The enormous wealth which the country produced had not diminished the poverty of the people. Mr. Thornton said the people were much better dressed, and he granted that a large number were, but at the same time the labouring classes, the serfs, the servants, and those who cultivated the ground, were in no better condition—he thought they were worse—than when he first went to the country. They were nearly naked, and their children were absolutely naked. When the country was dry and healthy, this did not much matter, but now that the atmosphere was constantly moist, to be naked meant death, and they died accordingly. In one year of epidemic sickness, in the Jhung district, of every hundred children born eighty died within a year. That was because the river overflowed its banks, and several hundred square miles were converted into a temporary marsh. With regard to a remark of Mr. Thornton's, that the people of Kashmir were a miserable set, he would only say that he was in Kashmir the year before he left India, and on returning, he had a conversation with Sir Charles Aitchison, and expressed to him the sad contrast which he found on entering the Punjab. In Kashmir the people had a fine, robust appearance; they were all well clad, in good homespun woollen serviceable clothes. In the Punjab they were badly clad, and instead of having clothes of their own native manufacture, even of cotton, they purchased Manchester goods, which were cheaper, but which were utterly useless for the purposes of protection. With regard to his remark that the statistics did not represent the causes of mortality, he would say that they were very useful as conveying a general idea, but were not of that elaborate kind which would enable any one to give the real causes of mortality with accuracy. It was unnecessary also to repeat them, as they had already been given by Mr. Thornton. His only object had been to follow up that paper by pointing out more in detail the remedies which were required for the evils which had been shown to exist. The same causes produced the same effects everywhere. Where there were many canals there was always a damp atmosphere, but in more educated countries the people clothed themselves accordingly. In India they did not. He did not suggest that the Government could do everything, but what he asked was that it should instruct its officers to teach the people how to adapt themselves to their altered circumstances.

APPLIED ART SECTION.

Tuesday, May 8th, 1888; R. BRUDENELL CARTER, F.R.S., Member of Council, in the chair.

The paper read was—

THE DECORATIVE USE OF COLOUR.

By JOHN D. CRACE.

The title of this paper is intended to indicate the limits which I propose to myself in dealing to-night with a subject which admits of consideration from several points of view, and covers a very wide field. Of the scientific side of colours I propose to say little or nothing; and of that side of the subject which relates to the pictorial use of colour I am also desirous of saying no more than is incidental to my own branch of the subject. My wish is to draw your attention to those principles which should, in my opinion, regulate and underlie all purely decorative work, when applied to forms and surfaces which—whether they appertain to buildings or to moveable objects, made by the hand of man—are not presentations of natural objects.

Unlike the works of Nature, the things which man invents and constructs for his own use, have their design based upon simple geometrical forms; and, in the majority

of instances, these are in some direction symmetrical.

In all parts of a building, and in a vast number of other products of man's invention, stability is the first requirement; and precisely in the degree to which this condition is important to the structure, is it important also that any colour, used decoratively on that structure, should assist and confirm the idea of stability or of strength.

In considering the lessons to be derived from Nature in the matter of decorative colouring, we must never lose sight of the great distinction between the forms to be coloured. In the case of Nature we may almost say that the forms to which beautiful colouring has been applied are never simple geometrical forms, and rarely have stability as a characteristic. Nature is always moving, always presupposes motion. Animals, birds, insects, foliage, flowers; these are the objects on which her most exquisite harmonies are lavished. All move, either actively of their own volition; or passively, by the action of wind or wave. If, therefore, we may seek in them instruction in the combination of harmonious colours, as we undoubtedly may, we must not look to them for instruction in the distribution and arrangement of colour upon objects and structures which are intended to be immoveable. We can follow them in colouring a fan, not in colouring a dome.

I lay stress on this distinction at starting, because I strongly advocate constant recourse to Nature; and to reap advantage from her teaching, you must beware against misapplying it. Moreover, the true lessons to be derived from natural objects are not to be fully learned from those objects detached from their natural accessories or surroundings. Something may be so learned; yet it is but a fraction of the whole, a word or two out of the poem.

We may certainly go pretty directly to Nature for lessons in one form of decorative art—I mean the art of dress—so far as the distribution and harmony of colour are concerned. I do not know to what extent the fashionable dressmakers make it a practice to study the combinations of colour in flowers, birds, and other living things, but I am quite sure that they can go to no better school; and I feel pretty sure that the most artistic designers of women's attire draw their best inspirations from these sources. After making the necessary allowance for complexion and other special circumstances, there is considerable resemblance in the conditions which would regulate the arrangement of colour in a lady's dress to those which are found in the plumage of birds. There are the same easy curves, the same variety of attitude, which render geometrical or very regular and symmetrical division unsuitable, and which, on the contrary, invite irregular forms, with the occasional piquancy of a suddenly accentuated contrast. In graceful movement or in graceful repose there is no symmetrical arrangement of the limbs, nor of the curves of the human body; nor, indeed, in animal form of any kind. Hence those surface divisions of colour are best which are independent of any one attitude; which, in fact, are not liable to distortion by each change of position.

But how different is every condition when we come to deal with a solid and inanimate structure. It is difficult to follow the rapid—and, to a great extent, unconscious—workings of the mind in matters of taste, and in the exercise of the critical faculties; difficult to distinguish what is due to discrimination, and what to association with some previous experiences. But there is one circumstance indispensable to the enjoyment of the beauty of any work of art. It is this. The mind must have no doubt—no misgiving—as to the object's stability; to that extent the mind must be satisfied at a glance. That amount of repose attained, it will (unconsciously) seek knowledge of the general form and outline; and only after that, will it settle into such a reposeful condition as to allow of the examination and enjoyment of detail. So long as any perplexity remains, the sense of beauty will be dormant, or nearly so, where the handiwork of man is concerned. Man must understand his brother man's work, or it troubles him. Now, it is just at this point that colour comes in with a few words of rapid explanation—if properly used. Colour will explain form at first sight (if used to that end), with a clearness and rapidity quite unattainable by form alone, and especially by form alone in a diffused light.

The reason why the exterior of a building is comparatively independent of colour for the expression of its proportion and of its structural lines is, that the stronger and more direct effects of light at once throw into relief the salient features. It is the reduced and diffused light of the interior which renders the explanatory help of colour so valuable, I was going to say indispensable. True, colour serves other and less simple ends; but that is its first pur-

pose; and to so use it as to explain simply and effectively the structure and proportion of the interior, and the direction and nature of its surfaces, whether plane or curved, convex or concave, is the first duty of the architectural colourist.

Be the ultimate object the richest splendour, the most elegant elaboration, or the most austere simplicity, the first consideration in the use of colour to any interior, or to any part of a building, must be that it shall assist and in no way confuse, that sense of repose which comes of a prompt recognition of its main forms and structural lines.

Now before proceeding to consider by what methods this object may be accomplished, I will here just anticipate a comment which will no doubt have occurred to many of you on this postulate. "This may be true," you say, "of such buildings as have architectural expression and structural features to deal with; but what of the numberless interiors and structures which have no such features and no such expression?"

To this I reply that, so far as the want of such expression is perceptible, the colourist's first aim in treating such structures must be to offer such a substitute as will afford the same mental repose. In other words, he will so distribute his colour that the forms brought into prominence may assist the idea of stability, and go to counteract any sense of apparent weakness or confusion.

It is, however, more convenient to deal first with that part of the subject which relates to buildings having defined structural expression. Now such buildings vary immensely in the extent to which they may be said to rely on their architectural detail for effect, or to be dependent on colour. Broadly speaking, one may say, "the more moulded surface the less colour," and the greater the necessity for extreme care in its use. In an interior which is already elaborately treated by the architect with mouldings and carving, and the surfaces subdivided into panels, simple "explanation" must be the aim. To distinguish the really important structural features from the mere subdivision of intermediate space, and to do this without detaching them, is the first object. There must be the same sort of relation between the major and minor structural lines that there is between the trunk and its branches.

Take the case of a vaulted hall or church, with arches and vaulting springing from piers or columns. A relationship must be maintained (whatever the extent or scale of colour) not only between piers, architraves, cornices, and archivolts, but between these and such minor divisional features as subdivide the surfaces between them. Subdued in tone these last may be, but not removed nor sharply contrasted. The broad contrasts must be between the structural forms generally and the spaces or surfaces between them; whilst the sharper, more vigorous relief of colour must be within the limits of—and expressing the direction of—the structural features themselves.

But, again, there are many buildings which having the same main constructive features as that which we have been considering, have no such minor or secondary moulded divisions. Each bay of the vaulted roof may be a blank surface. We have then to consider what alternatives may be adopted in treating these blank spaces.

Firstly. It may be contemplated to devote them to a decorative pictorial treatment, without actual subdivision. This will rarely be quite satisfactory; because any pictorial representation, straying, as it were, over a large area of curved surface, produces some confusion as to the form of the surface, and what is architecturally more important, leaves the structural lines too detached from what they should support—standing in fact like the bare bones of the whole. In such a case, however, this ill effect may be much moderated by interposing, between structure and panel, a band or bordering of such colouring as will, while supporting and spreading out the constructive arch or rib, ally it in some measure with the colouring of the panel.

But, however excellent may be the pictorial work, it will be seen to far more advantage if it be framed and supported by such dividing margins as will serve at once to suggest the contour of the surface, and to limit each pictorial area to such space and form, as can well be seen from one point of view. It is not necessary that these minor dividing bands should represent actual or possible structure. It is sufficient that the major lines of construction are expressed, and that the contour or section of the spaces between is explained by lines which become the equivalent of the minor construction—and suggest the ramification or network of support.

There is yet another type of internal structure, which may be founded upon the same general lines as those we have just considered, but is divested almost entirely of mouldings, or moulded relief. Such buildings are de-

pendent for their effect entirely on their coloured decoration, and are, perhaps, so built with the express object of affording scope for such treatment. Firmly expressed lines, and borders of colour, take the place of mouldings; and these must have sufficient force to make clear the structure, and to define the limits of the several areas of surface.

It is upon interiors of this last type that mosaic decoration may be most advantageously employed. This magnificent method of decoration by colour does not accord well with the use of mouldings, except to the most limited extent. Its nature demands exceptionally bold treatment, and the very strength and brilliance of its effects destroy all perception of the delicate shadows and roundings of good mouldings. It demands large surfaces, and is most effective where the surfaces are curved, these affording that variety of angle to the light which gives such splendour of effect to the gold grounds. It is under such conditions that mosaic is used in St. Mark's, at Venice; in the churches at Ravenna; and in many other of the best examples.

In the course of the foregoing remarks I have repeatedly spoken of the need for lines or divisional margins to "explain" the contours or planes of large surfaces. It is perhaps necessary to show why they are required, and how they serve the purpose.

It will be obvious to anyone who considers the matter that it is only by *its external limits*, or by some indication of shadow or other incident, that we feel at all sure whether any large surface of one tint is perfectly flat, uneven, or curved. We can see that a plastered wall is bulged if we look at it edgeways against the sky or against some vertical line; but if we stand facing it, and the light be diffused (that is to say, if there be no cast shadow), we can form no true opinion as to whether the wall is a true plane, or bulged, and out of upright. But if, instead of being plastered, it be a brick or stone wall, with straight horizontal courses, every joint which is above or below the sight-line will at once betray the curve of the bulge, and will indicate whether it be convex or concave. These horizontal joints will not, however, tell us whether the wall leans bodily in or out, or is "hollow" from top to bottom; we must look for some continuous vertical joint, or to some door or window opening, to betray this. We must, in fact, have the means of comparison which a straight line, or a line of known direction, will afford.

Now let us see how this applies in decoration. We will take a feature over the treatment of which there has been much discussion during the last few years—the "cupola" or interior of the dome. Suppose that we are standing under and looking up into a plain undecorated cupola, what do we know at a glance as to its form? What remains in doubt?

Well, we know, at once, that it is circular in plan; we learn that from the cornice, from which it springs; but beyond that, and some chance indication that its vertical section is curved, we know nothing. Whether that vertical curve is high or low, elliptical, semicircular, or segmental we do not know, and cannot so much as guess, until, by dropping a series of vertical lines on its surface, we exhibit its vertical section. Then doubt disappears, and the eye, relieved from perplexity, and satisfied as to the stability of the vault, soars up the curved line, grasping the whole meaning of the noble form, and ranges tranquilly among such detail as may occupy its surface.

Now, as the cupola is explained by these vertical lines, so is a barrel vault explained by the archivolts which divide it into bays, and by the other framing lines between them; whether they be in colour or in relief only. So groined vaulting is explained by its ribs; and where the builder has already provided such explanation, the decorator must confirm it; where it does not exist, he must supply it.

Let us now consider what is to guide the colourist in dealing with interiors which have no structural features to emphasise; which, in fact, cannot be regarded as architecture at all. If such be of a size, and for a use, which seem to call for some attempt at imparting dignity to its effect, it will probably be desirable to suggest, by the decoration, some structural division. In some cases the addition of a frieze will establish more agreeable relations between the walls and ceiling; in others some vertical division of the walls—which may form points of departure for division of the ceiling—may greatly enhance the dignity, and improve the proportion of a plain room. In any case, if there be any strength of colour in the ceiling, there should be, at some points, strength of colour leading up to it. In rooms for domestic use, these are often practically supplied by the window hangings, and in the majority of such rooms the dimensions are so limited that the want of constructive features is not felt.

And it may here be remarked that one very broad distinction divides most domestic interiors from those which are intended for some public or special use, when the question of coloured decoration arises. In the latter there are no draperies, nor carpets, nor any of those accessories, such as furniture, which all play so important a part in the colouring of a private house. Consequently, in the absence of these, the decorative colouring of the building itself has to be more complete, its harmony more carefully balanced, more thought out as to the purpose and result of each tone used. The absence of the accessories of a house, with all their variety and irregularity, leaves the colouring of the building more exposed to view, and more directly challenging criticism. A firmer, surer, and more purposeful hand is needed for the colouring of a bare public building than will serve for the domestic interior, in which picturesque arrangement, suggestions of historical association or foreign travel, or the collector's taste, may often play a more important part than either architecture or decorative colour. Nevertheless, much may be done, even in a room of moderate size, to improve or make the best of its proportions, and to impart an interest to it as a whole, by the distribution and management of the colour. The flat ceiling which, being the largest unbroken surface in the room, always has a tendency to appear weak, may be lifted and supported by the lines or grounds of colour which form the framework of its ornamentation, being so arranged as to throw strength into the sides and angles; and these leading forms and lines may themselves be made interesting and suggestive by their combinations of curve or angle. It is a common error to suppose that colour will "bring down" a ceiling. This will only happen where the tones are too strong or too crude for those which occur on the walls and in the draperies. All ornament must be kept subordinate in strength of contrast to the tones of the framework or controlling lines. If this be neglected, a sense of confusion will mar the effect, and destroy the repose essential to success.

The use of polychromy for external decoration demands very careful attention; and the extent to which it is desirable, as well as the best methods for its exercise, have been much debated during the last thirty years.

I would venture to say, on this subject, that, in a building which has any pretence to architectural design, the polychromy of its structural features should be confined to that presented by its constructive materials. Yet, even such buildings present occasionally features or surfaces which may be so treated in colour (whether by mosaic, or even by the painter), as greatly to enhance the effect and value of the whole. I could point to numerous examples, both ancient and modern, of the successful use of colour in this way. Of modern instances, I may quote the great frescoes outside the Berlin Museum, where colour is used pictorially; or the merely ornamental colouring of the window reveals in the Chateau de Blois; or, again, the very skilful introduction of mosaic ornament in the brickwork of the Trocadero at Paris—all of which must, I think, be admitted to contribute largely to the effect and value of the buildngs themselves.

But there is another class of building, of which we have only too many examples here, which afford occasional opportunity for some amount of colour treatment. I mean the stucco-fronted houses, in which design can hardly be said to have a place. Their "architectural symptoms" are of the slightest, and they, in any case, have to be painted in some way, periodically, to preserve them from decay. Here there would seem to be a fair field for careful schemes of colour, and I have observed a few very able instances of the external treatment of such buildings. Certainly, there is a growing taste for some application of colour to such houses, even where they are private residences. One such residence near me has recently had its ground story (including the front door and area railings) pointed the colour of red sealing-wax. After this, I feel that it is not timidity that restrains us in this matter. What we seem to want is judgment—a knowledge of how to compensate, by simple means, for the want of beauty and interest in the structural form.

There is, again, the detached villa, which, being less prominently exposed to public view, might often be made a much more attractive and more refined looking building, and be brought into better harmony with its small pleasure garden by a little skilful colouring than it is when its stucco surface is left with the usual two coats of "light stone colour." Many a small suburban house in the outskirts of Paris has so been treated, with the result of presenting as much outward charm as if many hundred pounds had been lavished on architectural refinement.

True it is not so permanent; but is our lease-

hold tenure so permanent as to offer much inducement to us to spend money on permanent adornment? The great majority of us think ourselves lucky if our interest in the house we live in extends to 20 or 30 years; at the end of which time our ground landlord swoops down on us with a bill of dilapidations, with an extra rent-charge, and probably a demand for premium based on our own improvements. It is quite a question whether the house will last another such term; for it must be admitted that, however charming, your stucco villa is not a very long-lived piece of work. Not that I join in the abuse of stucco, for under the short-lease system you probably get a better and more weather-tight house for your money, if it be of the modest "stuccoed" order, than if you attempt one, at the same rent, in sculptured freestone or ornamental brick. Only it is better to treat it as stucco, and to do your best with the paint pot, than to make believe it has a noble stone frontage.

The same general rules which should regulate the distribution of coloured form on parts of a building apply, with reasonable modifications, to smaller objects. Take pottery. If a vase or cup has a graceful contour, it is obviously desirable that any variety of colour used in its decoration should assist in showing its form, not disguise it. Very beautiful art is often expended on such articles with the result of actually detracting from their beauty of outline. I am not speaking of modern English pottery in particular. It is a mistake common enough in the finest manufacture of other countries, and it seems to me a quite unnecessary mistake. Of course, very exquisite painting will charm, even when used to poor advantage, but its merit of execution does not altogether justify its misapplication. In our own time, and in our country, it is a great misfortune that all our best artists learn to paint for a gilt frame alone, and are, for the most part, absolutely untrained in thinking out their subjects for any other application. I cannot but think that in this matter our Royal Academy of Arts might effect much reform, and give an immense impetus to the artistic excellence of the productions of this country, if, from time to time, they admitted to their exhibitions some proportion of objects of applied art of a high standard. It would encourage the best men to throw some, at least, of their best work into branches of art that can never rise to the highest level unless they draw to their service the best men. It was these branches of art that went to build up the fame of the greatest artists that the world has known; and I confess to the opinion that, so long as our highest art training has no other object than the production of detached pictures, destined to no special purpose or position, painted to no requirement, having for object chiefly to catch the eye of the buyer, so long the standard of art will drift right or left, to this or that particular fashion of excellence; but, being without purpose, will never attain to any very noble rank.

I am afraid that my discourse to-night may provoke the criticism that, being "on the use of colour," it has mentioned no single colour, has suggested no harmonies, has indicated no contrasts. I must plead that these omissions were intentional, not because I think these things in themselves less important than the matter I have spoken of, but that they are now frequently and ably treated, and are daily better understood. I was desirous so to limit my subject as not to divert attention from my main proposition, which is, that whatever the tones of colour employed, whatever the scale of harmony, no "decorative use of colour" can be really successful which is not based on the intention to do the best possible for the thing decorated. And then I go a little further, and say that no art can really attain the highest excellence if it has no broad purpose, no alliance with its sister arts. The art which is shut up in itself, whose masters have neither trained knowledge of, nor sympathy for, its allies, whether humble or noble, can never be progressive. In art, as in life, man's noblest work is most often produced in the earnest effort to ennoble and complete the work of others.

DISCUSSION.

The CHAIRMAN thought that all those who, like himself, endeavoured within the compass of their means to make their dwellings pleasant to the eye, would gain something from the paper, and from the information which it contained as to the true principles upon which that end could be attained. The principle that colour should be used as an explanation of the structure was to a great extent new to him, and one which seemed to possess very extensive and very far-reaching applications, which seemed to point to improving methods of decoration in their homes, and to be in every way worthy of their careful and respectful attention. With regard to the red sealing wax house, he did not know whether Mr. Crace referred to the house which he was acquainted with, but he

(the Chairman) knew that the explanation of the occupier having painted his house that colour was not the absence of timidity, but a consideration of the commonest and coarsest utility. It was inhabited by a gentleman who was a leader writer on one of the daily papers, who habitually went home from his office in a cab, and as soon as he got into the cab fell asleep, and did not care to awake until he reached home. He, therefore, had his house painted a bright red, because he used to say to the cabman, "Drive me to such and such a street, and stop at the red house." Therefore, there was no possibility of mistake, and no difficulty in arriving at his destination.

Mr. DONALDSON thought it must be a matter of some humiliation to Englishmen that the decoration of our noblest buildings was still unaccomplished, and that even St. Paul's Cathedral, which was a subject of extreme difficulty to treat, had never yet been dealt with in the masterly way which they all felt was possible, and which some of them hoped they might live to see. In confirmation of what Mr. Crace had said as to the value of colour, he remembered that in Dresden one of the walls of the city, which would be one of the ugliest walls otherwise, had been used as a decorative medium. Along the whole of the side of the palace wall there was a magnificent tableau in four or five colours, representing the history of Dresden, from almost the earliest period to the present day, and any intelligent person seeing that wall could not fail to be struck with the exceeding value of it as an educational instrument, not only to the population of the city, but to everyone who visited it. He was reminded, also, that in London there were, happily, now some very admirable examples—for some of which they were indebted to Mr. Crace — of the external decorations of houses. One of them was the establishment of Messrs. Novello, in Berners-street, which was decorated with very delicate and refined taste. He ventured to remark in that room, some time ago, upon what he must call the *laches* of the Royal Academy, and he could not help thinking that the Royal Academy failed in fulfilling one of its chief duties, namely, that of instructing the English public in the matter of decoration. He could certainly count on the fingers of one hand, the number of men who could in any way pretend to be decorative, as well as pictorial artists, amongst that distinguished body, and he thought that he might complain, with justice, of their want of sense of public duty in not educating the general public in the true principles of taste in that respect. There was no doubt that in this country the people laboured under a disadvantage. A few days ago he was in the Salon of Paris, where he saw a large number of works of pure decoration, many of them ordered by the city itself, and others destined for various cities throughout France. There was no doubt that the French decorators had a stimulus to effort, and an encouragement for their labours, which were wanting in this country, and it was very much to be regretted that, owing perhaps to the idiosyncracy of our character, there was not that appreciation of the decorative art which could be desired, nor the encouragements for the production of works of decoration which were to be found in France. The Salon, at Paris, presented one of the most remarkable contrasts to our Royal Academy, and showed what a fine field there would be in this country for the exercise of the very highest expression of taste, amongst decorative artists. He hoped that before very long the Corporation of London, and other representative public bodies, would rise to a sense of their duty in that particular, and that they would see town-halls, and other important public buildings, as well as the large private houses in this country, showing some of those decorative works which contributed so much to the happiness and enjoyment of a life which was never too long and never too happy, and which demanded all that could be attained, by intelligence and taste, to render it agreeable and complete.

Mr. TARVER thought that Mr. Crace must have had in his mind the dome of St. Paul's when he was speaking of expressing internal form by means of vertical lines. Many suggestions had been made when that building was under consideration, and it certainly seemed to him that the use of vertical lines was indispensable to an appreciation of that noble dome. With regard to what had been said as to the possibility of ornamenting stuccoed houses with paint, he thought that the prevalent fashion which came in a few years ago of painting them deep red was a mistake, although he thought that a house which was constructed of red materials looked well. He was glad to hear that Mr. Crace had not confined his praise to old examples only, but had referred to several modern examples as well.

Mr. MATHERSON thought that it was not realised, except by thoughtful people going through the streets, how very necessary such papers as they had heard were for educating the public taste. With regard to painting houses red, he thought that the feelings of the opposite neighbour of the owner of a house who purposed painting his house red should be studied. It must be very irritating to some people to find a house exactly opposite to them painted the colour of sealing-wax, and he thought the utilitarian excuse of the Chairman for the gentleman he had mentioned was hardly a good one. He did not at all wish to offer any opinion from a decorative point of view, but merely wished to speak on behalf of his neighbour, and he thought that in these cases what was wanted was the education of the public taste, and that there was an absolute necessity for papers of the kind to which

they had listened, for educating the public up to what was due to their neighbours in the way of decoration.

Mr. G. A. THRUPP said that Mr. Crace had given them a suggestive paper which would bear fruit, although at present he had put forward no pronounced lessons. He thought they must not be content to educate the taste of the public, but that there should be some censor of the metropolis, who would lay down a rule that in no street should the painting of individual houses be given up to the tastes of the inhabitants, but that a law should be laid down, as was was the case with the houses in the Regent's-park, where the whole of the houses in a row should be painted, say, every leap-year, so that one should not be painted at one time and another at another, but that all should be painted at one time, and of the same colour. Some of them could remember the time when the Quadrant used to be invariably painted at one time, and of one colour, and by that means a more pleasing effect was certainly obtained. They had for a long time supposed that where matters of contrast were put before them they must be put in a very symmetrical manner, but they had learned that that was not the teaching of nature, nor was it the practice of that nation whose achievements in art seemed destined still more to surprise them—the Japanese. In their works was to be found contrast, and want of balancing proportion was distinctly apparent. In the whole of a large composition there might be found a certain amount of balance, but in the detail there was not. Again, in nature, they would see very much the same kind of thing. Take, for instance, the colour of the tiger, and the way in which the stripes were distributed over the body. They were not all the same shape and direction, but they were so arranged as to give a pleasing effect. For want of remembering these principles they missed something in some of our most noble and recent public buildings, which they could not define until perhaps they heard it explained by an expert. As an instance, he would allude to the Memorial Chapel at Windsor, where one felt sensible that there was something wanting. There the whole of the surface, not only of the walls, but the ceiling, and the floor and windows were all broken up into an infinite variety of small objects, and he was told that if the windows had been all of one colour it would have thrown out and shown up the infinite variety on the walls. He thought what was wanted was a broad teaching from the experts in colour, the Royal Academy, and he believed if they would give more encouragement to the sister arts that it would do more towards educating the public taste than anything else. He was glad to see, that in a late address, the president of the Royal Academy had spoken with much satisfaction of the result of the Exhibition during the winter in comparing with pictures by the old masters a number of objects of art, such as statuettes and medals and bronzes and other things, which could not fail to have improved the public taste, and reminded them that in the former days there were other objects of beauty besides pictures only.

Mr. CRACE said the discussion had thrown a light upon the origin of the red house which had not before occurred to him. The question of the decoration of St. Paul's Cathedral was such a momentous one, that he could not say he was very sorry that it had waited, and he thought perhaps it was just as well there should be a little more maturity of opinion, at any rate, before the dome was approached. He was inclined to think that the committee of St. Paul's were rather disposed to begin at the wrong end, and had begun where they had far better finish up—with the most difficult part. He was sure if the artists of England, with their extremely limited decorative attainments, were turned loose in St. Paul's, those who lived to see the final result would not be altogether pleased by our being in a hurry. With regard to Novello's establishment, to which Mr. Donaldson had alluded, he thought the work was an admirable bit of external decoration, but there were other instances about London of decorations carried out with extremely good judgment, and which were very creditable to those who had executed them. The last which he had observed was an exceedingly creditable work, for the purpose for which it was executed, and that was the exterior of the Alhambra, in Leicester-square. With regard to vertical lines in a dome, it was quite true, as Mr. Tarver suggested, that he had in his mind St. Paul's; but in every dome that was the only way of finding out what the nature of the curve was. There might be all sorts of other methods of decorating a dome, more or less excellent, but if you wanted to know anything about the dome you must have the vertical division. Mr. Matherson's remarks as to the opposite neighbours he thought were justified, particularly in London. With regard to what Mr. Thrupp had said, he had confirmed very much what he (Mr. Crace) was anxious to lay stress upon, that the colour of animals was peculiarly suitable, as of course it was sure to be because nature never—or at any rate, very seldom—made a mistake; and in such accentuation of colours as in the stripes of the tiger, it was in the beautiful adjustment to the moveable form where they found the great distinction between what was applicable to that description of form, and what was applicable to the immoveable and absolutely stable structure. Mr. Thrupp had mentioned also the absence of completeness or sense of rest in the decorations of the Windsor Memorial Chapel. He should hardly have ventured to have picked out an example of how not to do it, but Mr. Thrupp had picked it out for him, and he could hardly have found a more complete example of what was to be avoided, because there all the different

colours and the brilliancy and effect was so used that the structural emphasis was lost sight of altogether, but he thought it was a great mistake to attribute that to the existence of stained glass alongside of coloured decoration, because that was not the first experiment of stained glass along side of coloured decoration. There were plenty of examples, one of the best known perhaps being in the church of Assisi, which he had mentioned, where the whole of the interior was painted in fresco, and the whole of the windows were filled with very beautiful stained glass. He had never heard anyone suggest that the interior of that church was a mass of confusion. It was because there those lines expressed how the building held together, and satisfied the mind that the building was a stable, well put together, construction, and did not leave the mind in doubt as to what shape it was. The chapel at Windsor was not well suited for mosaic. In decoration the less moulding there was the more mosaic, but that chapel was full of mouldings, and was not suited for mosaic. With reference to the Royal Academy teaching, he thought, and he was sure the President of the Royal Academy thought so too, that it did not do what it might do for the art of the country. As he had said, the art which only painted for the gilded frame would never be a noble art. After he had prepared his paper, the annual banquet of the Royal Academy took place, and he had read the speeches which were delivered. He found that the President had alluded to the Winter Exhibition, and had said that the thing which was most interesting to him was the water-colour room, which contained the collection to which Mr. Thrupp had alluded. The whole edifice of the art of Italy was built up on the fact that the artists whose works charmed them now were no trained alone by painting those works, but were trained by applying their art knowledge, not only to a canvas, or a panel, but to works which were intended for other uses. The sculptor was accustomed to execute his finest work for some building; the painter painted his best pictures for altar pieces, and did not paint only for a frame. He thought that a great impetus would be given in art instruction when the Royal Academy encouraged the men who now exhibited on its walls to turn their attention to something else than gilt frames, for, as long as the only object of the man who painted pictures was to catch the buyer's eye, they would never attain noble art.

TWENTIETH ORDINARY MEETING.

Wednesday, May 9, 1888; The LORD GRIMTHORPE in the chair.

The following candidates were balloted for and duly elected members of the Society:—

Campbell, Lieut.-Colonel Sir Archibald C., Bart., M.P., Blythswood-house, Renfrew, and 2, Seamore-place, Mayfair, W.

Chubb, Sir George Hayter, 128, Queen Victoria-street, E.C.

Clayton, Lemuel, Wellington Mills, Halifax.

Faulkner, Frank, Crosswell's Brewery, Oldbury, and 3, Furnival's-inn, E.C.

Manchester, The Lord Bishop of, D.D., Bishop's-court, Manchester.

Simpson, James, 8A, Rumford-place, Liverpool.

Smith, Alfred, Excelsior Chemical Works, Clayton, near Manchester.

Stanton, Edward Wollaston, M.A., 5, Verulam-buildings, Gray's-inn, W.C.

Taylor, Richard Strange, 83, Shardeloes-road, New-cross, S.E.

Watt, Hugh, M.P., 107, St. George's-square, S.W.

The paper read was—

LOCKS AND SAFES.

By SAMUEL CHATWOOD.

The subject of locks and safes is a very broad one, and only a small branch of it can be dealt with in a single paper. This paper is in the main devoted to locks and locking devices for safes and strong rooms, but even thus limited I shall only find time for an outline of the subject. It would ill become me to occupy the time of the Society by travelling over the ground so well covered by Messrs. Bramah, Chubb, and Hobbs, or to attempt a minute history of the inventions in locks which has already been so well given by Messrs. Tomlinson and Price, the latter having had the valuable assistance of the late Charles Aubin, whose lock trophy in the Great Exhibition of 1851, together with his own inventions in lock manufacture, entitle him to a first rank as an accomplished locksmith. I propose, therefore, only to devote a few minutes to a sufficient review of the subject of locks generally, to make myself understood by those not technically acquainted with the subject. Locks have been known and used from the earliest historic times, and ancient locks alone would find matter for an interesting paper, but I do not propose to discuss these, nor do I propose to deal with many ingenious locks, which have been invented from time to time, but which have not been extensively used, nor to deal generally with the question of safes and strong rooms apart from their locks and locking appliances.

Various modifications of what is known as the lever lock are chiefly used for safes in this country. The lever lock may be considered as

the natural outcome of the tumbler lock, which has been in common use for centuries.

The diagram on the wall, No. 1, illustrates an old safe-door lock. The wards are fixed obstructions more or less elaborate in the path of the key, and the tumbler, A, is a spring catch which holds the bolt in the locked and unlocked positions. To unlock this lock the key is so shaped as not to be blocked by the wards, also to lift the tumbler and engage with the bolt-tail.

The large bolts are thrown by the key instead of by a handle as in modern safes. The tumbler is protected by a box of wards, but the box of wards can be passed by the skeleton key which is so made as to avoid the obstructions of the wards. These are, of course, easily found by putting into the lock a key-blank of the right size, covered with a film of wax or gelatine. On attempting to turn the key the projections will leave their mark on the key-bit, which on being filed out will allow the key to pass. Should there be another set of wards beyond the first these will also leave their mark, and on these being filed out the key will at once lift the tumbler and pass the bolt. Tumbler locks are very extensively used as door locks and cabinet locks. A tumbler lock is very easily opened by means of skeleton keys, pick-locks, &c.

After the single tumbler lock, with its box of wards more or less intricate, came, in 1778, the invention of Robert Barron, which may be considered the real foundation of the modern lever lock, just as the Egyptian lock, with its gravity tumbler pins, was the foundation of the tumbler lock. Up to Barron's time the single tumbler had been placed under the bolt, which was without main stump, and was kept in its position by a narrow lip fitting a notch on the top of the tumbler. This lip was equal to the thickness of the bolt, and until it was lifted the bolt could not be moved. Barron dispensed with the overhanging lip, and introduced a main stump, which passed through a slot in the bolt just wide enough to receive it, and at right angles thereto another slot allowed the tumbler to be lifted too high or not high enough, in either case blocking the bolt. This was a great advance on the simple tumbler, which did not block the bolt however high it was lifted, provided only that this overhanging lip was lifted out of the top edge of the bolt.

Not satisfied with this, Barron superimposed two or more of these tumblers, each, however, having its own main stump, the slot of the bolt passing them all. A second slot in the bolt at right angles was provided for each tumbler, which allowed the stumps to be raised too high, or not high enough, for the passage-slot in the blot. In Barron's lock, the bellies of the tumblers were practically the same as the key, so that a skilful locksmith, having passed the obstruction of the wards, had no difficulty in ascertaining the pattern of the key required to lift the tumblers. Thus each main stump would be in line for the passage in the bolt.

It will be seen at once that here we have the foundation of our modern lever lock, the essential difference being, that in Barron's lock the gating was in the bolt, and the main stumps rivetted to the tumblers, whereas in the lever lock the single main stump is rivetted to the bolt, and the gatings are in the levers.

In the tumbler lock of Barron, the tumblers were raised, so as to be in line with the passage-slot in the bolt, and in the lever locks the levers are raised, so that the slot in each lever is in line with the main stump of the bolt. Barron claims, however, in his specification:—"The gating or racking to allow a stump on the tumbler to pass through the bolt, or an opening in the tumbler to allow a stump on the bolt to pass through;" so that, in reality, Robert Barron was the inventor, not only of the improved tumbler lock, but also of the lever lock itself, although in practice he seems to have preferred the tumbler, with its main stump, rather than the lever, with its gating.

The diagram on the wall, No. 2, represents an ordinary lever lock, in which wards are not generally used, except for arranging suites of locks, with master keys, &c., and in which the single tumbler of the tumbler lock is replaced by a number of levers. The bolt has fixed upon it, at right angles, a projection called the main stump, and each of the levers has a passage or gating, which, in a well made lock, should be no wider than is absolutely necessary for the stump to pass through. In unlocking the lock, all these levers have to be raised, each exactly to its right position, before the bolt can be withdrawn; if any one of them should be raised too high, or not raised sufficiently, the stump is blocked, and therefore the bolt cannot be withdrawn.

At the first glance it would appear impossible to pick such a lock if the number of levers be considerable. It is not, however, difficult.

The key has a number of steps, each of which, except the bottom one, lifts one of the levers. The bottom step then engages with the bolt, and draws it back. To pick such a lock pressure is applied to the bolt so as to cause the main stump to press against the faces of the levers; then, by raising each lever in turn, the position of the gating is easily ascertained by the difference between the friction on the lever when pressed by the main stump, and when in position, and no longer pressed by the main stump. In a lock with many levers special appliances are necessary for these purposes.

The apparatus used in picking lever locks consists of a tubular key having one step upon it, and a solid key fitting inside it, and also having one step upon it, having an ordinary key bow with a lever arm carrying a small weight. These can be operated quite independently of one another. The step on the solid key engages with the talon of the bolt, and the weight on the lever arm attached to it causes the stump to be forced with suitable pressure against the faces of the levers. By means of the step on the tubular key, the levers are raised in turn to feel for their gatings, and as each is found, extra pressure necessary to retain them in position, is provided by moving the weight along the lever arm. When all the levers have been thus arranged, the bolt is withdrawn.

The next great step was made by Joseph Bramah, the engineer, who saw the weakness involved in the patterned bellies of Barron's tumblers or levers, and set to work to design a lock where the levers, or sliders doing the work of levers, should be equal on the faces accessible from the keyhole. The Bramah lock, which, though now not much used for safes, enjoyed at one time a great reputation, is in principle the same as a lever lock; indeed, we have in this lock for the first time (except the simple extract which I have given from Barron's specification) the equivalent of the main stump of the lever lock. Instead, however, of levers we have slides of sheet metal working in slits in a drum, and pressed inwards by the key and outwards by springs. This drum in unlocking is required to be turned round. It is enclosed in a cylinder which has fixed to it a flat steel ring, projecting into a groove round the drum. This ring has slots or notches for the passage of the slides. The slides have also slots or gates in them of the thickness of the ring. It will be understood that the slides correspond to the levers and the ring to the stump of a lever lock. In unlocking, the key presses the slides down until each is in the position in which its "gate" is opposite to the flat steel ring. The drum can then be turned round. This lock can be picked by methods similar to those described for the lever lock and in other ways. There have been many modifications of the Bramah lock, but they are not extensively used for safes.

Having, I trust, clearly explained the principle of the lever lock and the method of picking it, I will proceed to describe some of the means in use to-day for rendering lever locks unpickable. I do not attempt to describe them in order of date, but in that in which they are most easily and briefly explained.

1. Notches or false gatings on the faces of the levers are shallow notches into which the stump can enter a short distance. It is clear that if these notches are numerous and carefully made it is very difficult for a picker to discriminate between the real and false gatings.

2. The barrel and curtain consists of a cylinder or barrel with a disc attached, capable of revolving. The key is inserted in this barrel, with its bit projecting from the side, so that when one picking tool has been inserted and turned, the keyhole is closed and a second tool cannot be inserted. Against such a picking instrument as I have described the curtain is of no value, but the barrel is of considerable importance.

In picking a lock with this instrument the bolt-step is required to remain constantly pressing against the bolt, the other step is required to move in lifting the separate levers. When both pass through the slit in the barrel, one cannot be moved without the other unless they are thinner than the right key, or the slit in the barrel is made wider.

While I certainly cannot say that a lever lock containing these two improvements is absolutely unpickable, yet their importance is illustrated by the fact that one very large firm of safe makers use nothing more secure, even on their most expensive safes, than an eight-lever lock with false gatings and a barrel.

3. The detector, to describe it briefly, consists of a trigger placed over the top of the levers, and so arranged that if any lever be raised too high the detector is operated so as to block the bolt. The bolt cannot then be withdrawn, even by its own key. The detector can, however, be released by turning the right key a little distance in the opposite direction. It is obvious that a very delicate and sensitive

touch is necessary when lifting the levers to find the gatings, to avoid raising them too high, and so detecting the lock.

It is impossible, in considering the means which have been adopted to render the picking of lever locks difficult, not to be struck with the originality of the invention of Thomas Ruxton, who, in the year 1816, took out letters patent for a very ingenious lock with a detector bar, which was undoubtedly the first detector lock patented. This was two years before the first patent of Jeremiah Chubb, and eight years before that of Charles Chubb, both of which patents related to detector locks. The detector lock of commerce is, however, due to the two elder Chubbs, who so simplified it as to command a general confidence, which has been well retained by their successors.

The lock controversy of 1851 brought to the surface all that was good in lock inventions up to that period, and produced what I have no hesitation in pronouncing the most important invention ever introduced in the construction of lever locks, *i.e.*, the moveable stump of Alfred Charles Hobbs. It is to this beautifully simple contrivance that we first owed the possibility of making a lock absolutely unpickable by the tentative process, without which the hanging lever of Charles Aubin carrying the main stump, and the false plate of George Price, with the same object, or my own safety lever might possibly not have seen daylight, as these and numerous similar means of defeating the attempt to pick by the tentative process are dependent upon Hobbs' invention of the moveable stump as the foundation on which they are built up.

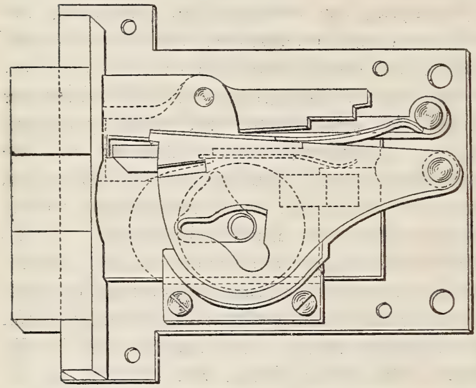
Mr. Hobbs laid down the proposition, which I think can so far not be controverted, "that whenever the parts of a lock which come in contact with the key are so affected by any pressure applied to the bolt, or to that portion of the lock by which the bolt is withdrawn, as to indicate the point of resistance to the withdrawal of the bolt, such a lock can be picked." The merit of Hobbs' invention consisted in making the stump—which up to that time had in all lever locks been rigid with the bolt—moveable, so that any pressure applied to the bolt before raising the levers to their proper position, instead of being taken by the levers, would be transferred to a fixed part of the lock, leaving the levers free from pressure.

A great impetus was given to lock invention by the picking of the best locks of Bramah and Chubbs, as evidenced by the records of the Patent-office. We find that from the year 1774, when the first lock patent, that of Black, was taken out, up to the end of 1850, a period of 76 years, only 87 patents in connection with locks and latches were applied for, whereas in the fifteen years following 192 patents were applied for in connection with locks and latches. This period of fifteen years starts with the great Exhibition year, and ends with the year of the Cornhill burglary.

The time at my disposal compels me to pass without mention many ingenious proposals for symplifying the construction, increasing the efficiency, and cheapening the production of locks, but one of the first of the important inventions in connection with locks, after the great lock controversy, and probably arising out of it, although never patented, was the beautifully simple lock known as the Dennison lock, for which the world is indebted to our worthy chairman, Lord Grimthorpe. In this lock the levers are a series of rocking levers, without springs, and kept from acting on each other by thin friction plates being fixed between the different levers. The gatings are in the open end of the levers, the key acting to depress the contrary end, so as to lift the gatings to bring them opposite the main stump when the bolt is withdrawn by a small knob. The bolt is also thrown by the small knob, which, as soon as the main stump leaves the gatings, acts by a separate limb upon the underside of the levers, behind the centre of motion, putting them in position for being acted upon by the key, for again unlocking. The key does not operate the bolt, and having only to depress one end of the rocking levers, can be made very small and light. When the key is in the lock, a small square plug, carried on the back of the curtain, holds the bolt fast with its main stump, clear of the ends of the levers, precluding the possibility of picking this lock by the tentative process, as only when the keyhole is fully closed by its curtain is the plug released from the bolt, allowing it to be moved by its handle. This lock, without the detecting apparatus introduced by the Chairman, marks a distinct step in advance, and has placed us under lasting obligations to Lord Grimthorpe for having given this invention to the world without paying the Government for the privilege of doing so, which is the penalty inventors, as a rule, submit to. No paper on locks would be complete which did not make honourable mention of the inventions of Tucker, Parnell, Tann, Price, Fenby, Hart, and Cottrell, all of which have demonstrated the possibility of producing

English locks capable of defying picking instruments in the hands of experts. I have already expressed my admiration of the moveable stump of Alfred Charles Hobbs, but even this had two defects. It was subject to the weight of the lever springs, and was accessible from the path of the key. It was to cure these two defects that I introduced my "Invincible" safety lever in 1860. This I

FIG. 1.



CHATWOOD'S SAFETY LEVER LOCK.

recess within the thickness of the bolt, and entirely out of reach of the path of the key, and I so mount it on a bell crank or a rocking lever, pivoted to the bolt, that I am enabled to make it just as strong as I wish, without destroying its sensitiveness. One arm of this lever carries the main stump, the other arm passes when the lock is working with its own key, just clear of a fixed stump or solid part of the case at the back of the lock. This lever is held in its position in relation to the bolt by a light spring. Now, if any pressure be applied to the bolt this lever is tilted, until the long arm comes into contact with the inclined face of the fixed stump, and the levers are perfectly free from pressure. This lock has never been picked, although it is now nearly thirty years since I introduced it. I believe it to be absolutely unpickable.

A very important requirement in safe locks is that no two should be alike, in order that there should be no possibility that the key of one safe should open another.

The method in use in my works, and also I believe in some others, renders it absolutely impossible for two locks to pass unless specially made to do so. The key consists of a number of steps corresponding to the number of levers, say, for example, eight. These are of different lengths. They are cut out of the key blank by eight circular saws of different diameters placed in a pack on a mandril. The key-blank is held in a special vice fixed on a slide rest, and is brought forward against the saws by the screw of the slide-rest.

The saws thus cut out the steps. Each of the saws is numbered, and for the first key they are placed in the order 1, 2, 3, 4, 5, 6, 7, 8, for the second in the order 1, 2, 3, 4, 5, 6, 8, 7, and so on. The number of changes, *i.e.*, the number of different keys which can be cut with a set of eight saws, is 40,320, which may be extended almost indefinitely. To make a second set of 40,320 it is only necessary to alter the diameter of one of the saws, or to vary the depth to which they are allowed to cut into the key-blank.

Keys are made in this manner for store. When the locks are finished with the exception of the cutting of the gatings, the locksmith receives keys from the store, and marks off and cuts out the gatings to correspond with them. The lock is made to the key therefore, and not the key to the lock.

A very beautiful machine was introduced by Mr. Fenby for cutting his key-bits by the use of one saw, but I prefer the plan of having a number of saws equal to the number of levers, each saw of different diameter from any other, and carrying its own number, and transposing the saws for each set of keys.

In locks for safes we have more requirements to consider than that the locks should be unpickable. For example, they must be gunpowder proof; capable of working for many years without being cleaned or attended to. They must be strong enough to withstand any instrument capable of being inserted in the keyhole, they must not be liable to get out of order, and the keys, when these are used, must be of convenient size. In modern safes the bolts are thrown by the handle, and the lock is used to secure them in position. Thus the key has little work to do, and does not require to be large.

No safe should be made so that the key can be taken out without locking the bolts of the safe, either in the locked or unlocked position, so that before moving the handle the key will require to be inserted. My earliest arrangement for preventing the key being taken out of the lock without locking the safe had its origin in a very peculiar circumstance.

About 1859, a robbery took place at the offices of Messrs. Parry & Co., coal merchants, at Liverpool, when one of Milner's safes, having Hobbs's lock on it, was said to

have been opened by burglars, and robbed. I was consulted with respect to the matter, and I stated that in my opinion the safe had either been opened by the use of its own keys, or that it had not been locked. Up to that time safe-door locks had always been made in such a manner that the keys could be taken out when in the unlocked condition. I at once saw that it would be possible to design the lock so that its key should always throw the bolt when taken out of the lock, so that if the door was closed, and the key taken out of the lock, no question should arise as to the safe being locked. Since that time I have made this a distinguishing feature of my safe-locks.

I did not take out letters patent for this invention, thinking in my youthful simplicity that my lock maker, Charles Aubin, would confine it to my safe-door locks. Aubin used also to make the locks of Price, and the late Mr. Dawes informed me that Aubin had submitted my unpatented invention to George Price, who was unable to use it for his safe locks because he used back bolts, which if locked out with the safe door open would be liable to injury. He thereupon designed his divided bolt-head and double-acting lever, in order that he might make this invention applicable to his safes with back-bolts, as by making three notches in the top edge of his bolt-tail he could lock the divided bolt of his small lock with the large bolts in the lock-case unlocked, or in the locked position, but while retaining his back bolts he could not use the bolt of the small lock as a filling in piece at the end of the bolt-tail, and so transfer the strain to the solid part of the large lock-case.

Circumstances like this occurring from time to time led me about 1862 to establish a department for the manufacture of my own locks. I have here the first lock made at my works; in this lock the space for gunpowder is smaller than in those in general use, as the bolt is driven by a cam to which motion is given by a projecting bit of the key, so dispensing with the ordinary talon of the bolt and its open space. I had in vain endeavoured to get this lock made at Wolverhampton. I have here also the second lock made at my works; this lock has fish-tail levers requiring no springs. Both these locks are made unpickable by the use of safety levers, the same as my ordinary safe-door locks, a sample of which is on the table. Fig. 1 (p. 708) shows my ordinary safe door lock with its safety lever carrying the main stump. The form of lever is different from that most commonly used. It is open-fronted, and the key, instead of lifting the levers from below, and making a complete revolution, lifts them from within themselves, and is only allowed to move one-third of a revolution. The chief advantages derived from this are, that the space available for gunpowder, in any attempt to blow up the lock, is very limited, and cannot be enlarged by ramming, and that, as the key cannot be taken out in the unlocked position, the safe cannot be left unlocked if the key is removed. This I consider very important, both to guard against carelessness and to insure that the bolt of the lock shall be fully thrown and the stump clear of the levers. If the bolt step of the key of a lock with the ordinary form of lever be worn it will not fully throw the boilt, the stump will remain in the gate of the levers and the bolt can be withdrawn by a piece of wire. I have no doubt that there are a great number of safes in use the keys of which have been turned nightly, but which have from this cause never been really locked for years.

Below the levers is a rest which prevents any instrument inserted in the keyhole from forcing the levers downwards so as to allow the main stump to pass over them. This rest also takes the pressure of the lever springs instead of allowing it to rest on the main stump. The key is a pin-key, which is case-hardened to resist wear, and which works in hardened steel bushes in the cap and plate of the lock. The springs of the levers are solid with the levers themselves, the lever with its spring being pressed out of hard rolled brass. The bolt is guided on fixed stumps, and the head of the bolt has a channel for the escape of the gases of exploded gunpowder.

Except the pins and bushes, the lock is made wholly of brass. Most makers use iron, cast, malleable, or wrought, for the cases of their locks, and for some of the internal parts. This I consider a most serious fault, as safes are used in all sorts of situations, and under all sorts of conditions, in which an iron-cased lock will be affected by rust, &c., and therefore may not work satisfactorily. The sacrifice of efficiency is a serious one, and the economy paltry.

The development in the design of locks rendered the attempt to pick tedious, and attended with much risk, and caused an alteration in the plan of operations of the burglars who, from being light-fingered lock pickers became skilled mechanics capable of using

the silent ratchet drill, the serrated wedge, and steel lever, cases became common where, avoiding the lock altogether, safes were opened by drilling holes and by forcing screws pushing back the main bolts, the small lock causing hardly any obstruction; in other cases the works of the lock were drilled away, while in others the door was forced open by steel levers, small wedges having been first used to bulge out the side of the safe sufficiently to insert the point of the lever. It was to render the drilling out of the lock impossible, that in 1860 I introduced the "intersection" of hard and soft metals, which should be able to withstand the impact of the hammer, be incapable of being drilled, and at the same time not be softened by the blowpipe. And to render the wedge and lever inoperative, in 1862 I introduced my T-girder frame and solid flange lock case, and in 1865 the making of the edges of the door curvilinear fitting into a curvilinear seating in the T-girder frame, and the making of the bolts with dovetail heads upon them, which, after the closing of the door, would pass into dovetail grooves in the back of the web of the frame of the safe. Safes up to this period were characterised by weakness instead of strength. I well remember being considered fit for a lunatic asylum when I announced that a safe to be really burglar proof must be not less than two inches thick of intersected steel, incapable of being drilled. and provided with suitable arrangements for preventing lateral strain, and it was not until the great burglary on Mr. Walker's premises, at Cornhill, in 1865, that I could obtain a single commission to make such a safe as I recommended. When that robbery took place the *Times* complained that the burglars had got ahead of the safe makers, and it fell to my lot to demonstrate that the fault lay, not with our safe makers so much as with our safe buyers, who had not been willing to pay the cost of such safes as could be called really burglar proof.

After the burglary at Cornhill I was consulted by the late Mr. Walker, and advised him to have a safe by some responsible maker of repute, who instead of giving a worthless warranty, which it might afterwards be pleaded amounted only to a trade representation, would show his own confidence by allowing the safe to be operated upon by burglars' tools for six hours, but the manufacturer to whom Mr. Walker had given a commission to design a real burglar proof safe, regardless of cost, preferred to throw up his commission rather than allow his safe, designed under these favourable conditions, to be tested, whereupon Mr. Walker instructed me to design a safe, the drawings of which should be approved by his engineer, the late Mr. Fairlie, the stipulations of Mr. Walker's commission being that he should be allowed to employ two skilled mechanics, working under such conditions as the chief of police would admit possible for burglars, to operate upon the safe for thirty-six hours before delivery.

Up to 1862 safes had been invariably made with straight bolts shot out from the edge of a chamber on the inside of the door which is known as the lock case, and which contain the boltwork and the lock; these bolts are usually shot only at the front of the door, and are all attached to a bar called the bolt-bar, having a limb projecting from it called the bolt-tail, into which the bolt of the lock shoots at right angles. The follower which moves the bolts works either on the bolt-tail or upon a separate limb or tail provided for it, the bolt of the small lock always shot into the bolt-tail, with no protection against side strain or pressure applied on the ends of the large bolts. I look upon it as a great importance that this boltwork should be arranged so that if holes should be made through the sides of the safe, no force applied to the ends of the bolts should be able to force them back; for this purpose the bolts should be recessed to receive the bolt-bar. The bolt-tail should be either made solid with the bolt-bar, or shouldered to receive it; the bolt of the lock should be equal in width to the throw of the safe bolts, and shoot into and completely fill the recess between its end, or locking shoulder, and a fixed wrought-iron piece called the lockstop, secured to the door, and extending backwards to the back flange of the lock-case.

It is, of course, of the utmost importance that the lock should be so securely attached to the door that it cannot be forced off, and also that all the parts of lock and boltwork should be attached to the door by blind screws, that is, by screws which do not come through to the outside, and therefore cannot be drilled or driven out.

It will be seen that, as the bolts shoot through and are connected to the door by the flange of the lock-case, however strong the bolts may be, and however good the locks, in the event of an attempt to force the door out, the crucial point is the manner in which this lock-case is attached to the door. Before 1862, this lock-case was a separate box, without any

return flange coming to the edge of the door, and screwed on to the door, which is, on the face of it, a very weak arrangement, as demonstrated in the case of the safe at Cornhill. Most makers adhere to this plan, notwithstanding the fact that my invention of the solid flange lock-case is now public property; some two or three, however, have discarded the separate box lock-case, and have adopted my solid fiange lock-case instead. I consider that the only possible method of getting rid of the weakness is to make the flanges of the lock-case in effect solid with the door, and this is carried out by my patent "Solid Flange Lock-case," which is shown by the models on the table.

At the hinge side, the door of a safe with straight bolts at the front, if fitted with the solid flange lock-case, does not really require any bolts, because at the back the lock-case is at right angles with the door, and would require to be bent before the door could be forced open. This bending is effectually prevented by the top and bottom flanges of the lock-case being placed inside or between the front and back flanges.

The bolts pass behind the web of the T-girder frame on the closing of the door. Some makers use sliding bolts at the back similar to those at the front. These are generally very inefficiently secured, and I consider dogs or fixed bolts much superior to sliding bolts at the back, as generally used. Safes, however. may have bolts at back and front, providing means be adopted for making the bolts continuous from front to back; this may be done by my self-blocking cam lock. This self-blocking cam has the ordinary eccentric slots for the pins by which the bolt-work is shot, but these slots are continued for a short distance concentrically with the centre on which the cam turns, so that after the bolts are thrown the cam can thus go on turning without moving the bolts. Solid with the cam are blocks which, by the latter part of the movement of the cam, are moved behind the ends of the bolts. Thus in the event of any attempt to force back the bolts, they are blocked solid instead of having to rely on the strength of the driving-pins. Sometimes, instead of flat bolts round bolts are used, and in some cases with advantage. One of these block cams is on the table.

Much ingenuity has been expended in preventing the bending of the sides of safes, and the many special forms of bolts now employed are designed for this purpose.

The first attempt to strengthen the sides of safes was by flat bands of bar-iron on the outside, a method still employed by most makers. This arrangement has been demonstrated to be utterly inadequate to the purpose for which it is intended, and it affords a most convenient means for fixing tackle for drilling, &c. My T-girder frame, in effect, takes the flat band just described, using it on edge instead of on the flat, and bringing it inside, and making it solid with the side of the safe. This gives the front edge of the safe lateral stiffness.

Diagram on the wall, No. 5, shows a front corner section of the safe opened at Cornhill. This safe was the strongest which had been opened by burglars, and while so deficient in lateral stiffness, was much stronger than nine-tenths of the safes in use as so-called burglar proof safes. This safe was opened by driving file-cut wedges between the front edge of the door and the side of the safe, making an opening for the insertion of a steel lever or crow-bar, which, of course, soon overcame the resistance of the screws holding the lock-case on to the door-plate.

Diagram on the wall, No. 6, shows the front corner of the intersected steel safe I designed for Mr. Walker after the robbery, undoubtedly the strongest safe which had at that time ever been made. The curvilinear edge of the door, closing against a curvilinear seating in the side framing, rendered the driving of a wedge impossible. The sliding claw-bolts of the solid flange lock-case, fitting into dovetail grooves planed out of the solid web of the T-frame of the safe rendered the wedge and lever powerless, apart from the ogee edge of the door, and the intersection of hard and soft metals incapable of being softened by the blowpipe, rendered the drilling of the lock an impossibility. The intersecting metal was hematite in some cases, but usually spiegel, both of which having been made red hot by the blowpipe, would be just as hard when cold as before, and if any attempt was made to drill while still hot, the drill would at once lose its temper and refuse to work.

This T-frame, in combination with my solid flange lock-case, has been common to my safes since 1862. Fixed projecting pieces of various forms, passing into holes or recesses in the sides of the safes on the closing of the door, have been, and still are, much used for this purpose. Used in combination with the forms of hinges in use in

England for safes, such fixed wedge guards give a totally false appearance of strength, as they cannot be applied at the back or hinge side of the door, where, in the absence of the T-frame and solid flange lock-case, they are quite as necessary as at the front. In some cases they are so badly contrived that the recesses in the frame materially reduce its stiffness.

The model on the table illustrates the use of the claw bolts, which are dovetail claws projecting from the lock-case, and moved parallel with its edge. When the door is closed, they pass through the gaps in the T-frames, and on being thrown by the handle engage with corresponding dovetail claws cut out of the solid T-girder frame, thus securely gripping all sides of the safe. The bolt-bars are recessed into the bolts, so that the power of resistance to wedge and lever does not depend on the rivets or screws by which the bolts are attached to the bolt-bar. It is impossible to drive them back if access be obtained to their ends, and in this respect, as well as in the more accurate fitting, which is possible with them, and in the direct grip which they take of the frame, I consider them much superior to any other contrivance of the same class.

Many other forms, in addition to my claw bolts, other than ordinary straight bolts, have been used, such as screw bolts, actuated by the handle, and screwing into the side framing of the safe.

The diagonal bolts of Chubb, are straight bolts thrown radially from the lock-case into bolt holes in the side framing of the safe.

The hook bolts of Hart, which, as their name implies, are of a hook form, are pivotted on the door, and are caused to rotate by a bolt-bar moved by the handle in rotating, the hook portion is caused to project from the lock-case, and to hook into the side frame of the safe. The strength of such a bolt is just that of the pin on which it turns. Another arrangement is shown by the rough model on the table, which is a kind of hinge fastening, one half being rivetted to the side of the safe, and the other half of the hinge being attached to the door. This is the invention of a working man in Salford, named Gardener, who came to me in 1869, with his model, saying that he was advised that he could not get a valid patent, because my claw bolt patent would cover it. He, however, signed a declaration, so that I might patent it in his name if I wished, but as I did not consider it equal to my claw-bolt, I did not do so.

Fig. 2 (p. 713), shows the lock and bolt work of one of my banker safes, looking from the inside with the door locked and the lock covers removed; the bolts dovetail into the side framing of the safe, and a composite lock, like the one on the table, is used to secure these in position.

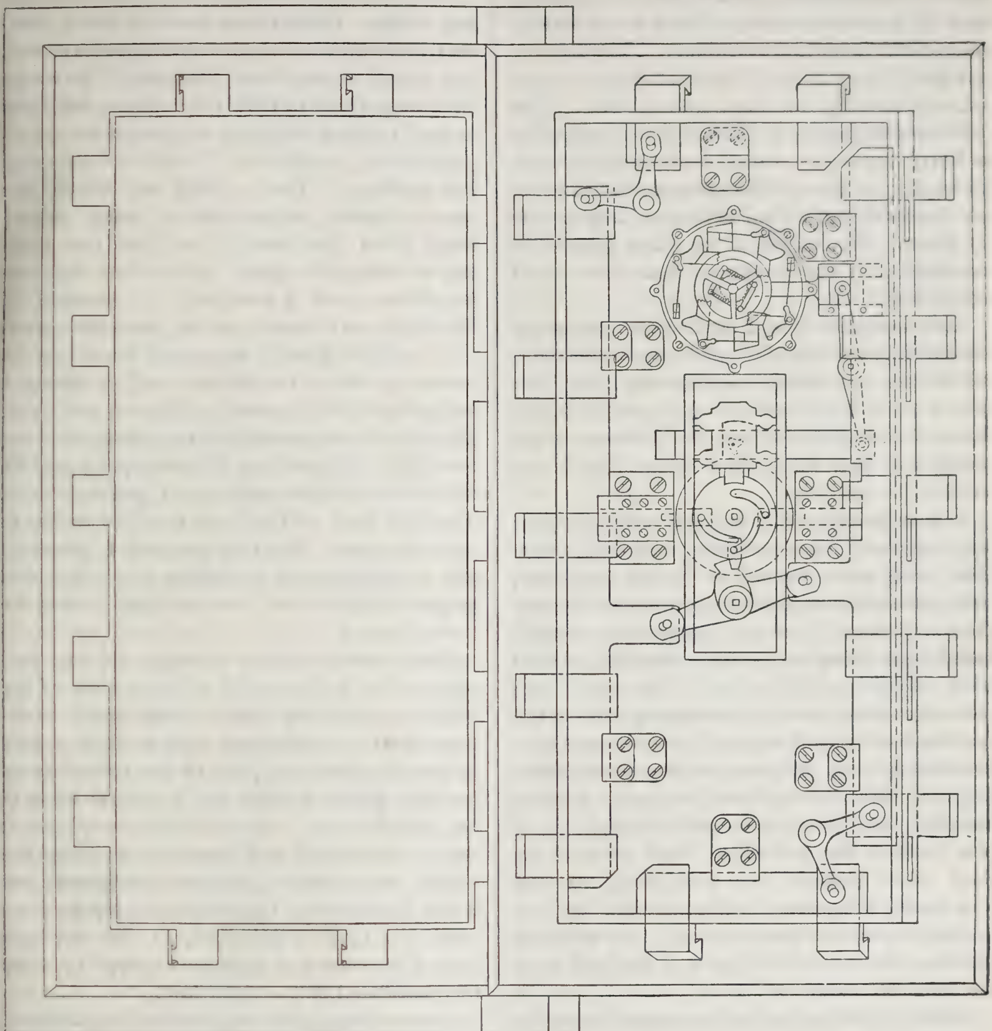
This lock consists of a case containing a double follower, which throws the bolts, and above it a cam throwing three bolts, one of these engages with and locks the double follower, the other two shoot out sideways in strong guides into the front and back bolt-bars. These two bolts have stumps upon them which, in unlocking, have to pass into gatings in the large circular levers, which have their centre on the same axis as the cam, and are operated by one of the "bits" on the key. There are two bits on the key, and the bottom one works a separate "Invincible" lock, the bolt of which shoots into the cam. It will be seen that in addition to such a lock being absolutely unpickable, it is impossible to force it, and that in consequence of it locking at several points, even if it were possible to drill the door, the lock would, practically, have to be completely cut out before the boltwork could be disengaged, and the safe opened.

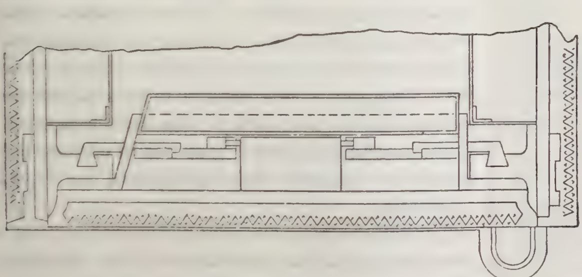
The keyhole passes through a steel bolt bar, which, when the key is withdrawn, is shot by a knob and secured by a combination letter lock, like the one on the table. Sometimes I dispense with the separate knob and throw the keyhole bar by a cam in the plate of the combination lock direct. This arrangement shuts off all access to the lock. The sectional plan shows the curvilinear edges of the door fitting against the curvilinean seating of the side framing of the safe. The claw-bolts of the lock dovetailing the door and sides of the safe together, also the conical intersection of the hard and soft metals for the protection against drilling and the softening by the blow-pipe.

This plan also shows clearly the T-frame and the solid flange lock-case, which, in my opinion, are unquestionably two of the most important inventions ever introduced in the manufacture of safes and bank strong rooms. In first, the range of their applicability; second, in the comparatively small cost of their use; third, in the perfect security which they afford against wedge lever and forcing screws; and fourth, in the great rigidity given to both door and safe body by their means.

I quote with pleasure the following extracts, which are descriptive of my patent T Frame and Solid Flange Lock Case, from the printed

Fig. 2.





Chatwood's Intersected Steel Safe.

Showing:—1. Intersection of hard and soft metals. 2. T-girder frame. 3. Solid flange lock case. 4. Curvilinear edge of door fitting with curvilinear seating in side framing. 5. Composite multiple point lock. 6. Keyhole bolt bar controlled by unpickable combination letter lock and flexible spindle. 7. Sliding dovetail claw bolts securing door to sides of safe.

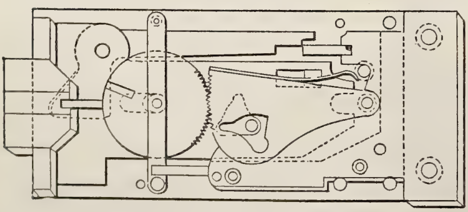
trade catalogue of one of my competitors:—"The frame being a special T-iron section with thickened corner its strength is enormous, and the power necessary to bend it can hardly be applied except by machinery. The bolts of the lock fasten behind this solid iron, in place of, as is usually the case, into a lining. The bolts and lock-case are fastened to the door by a heavy angle iron frame, and in any attempt to force open the safe the pressure would come on this solid angle iron, and not on any screws or rivets. The edges of the outer plates are recessed into the frame, so that there is no open joint."

So thoroughly have I made this system my own that about twenty years ago I discarded all others, and since that time my firm have not made a single safe of any quality which has not been provided with the T-frame in the body, and the angle iron frame above described on the door.

I now describe the locking arrangements for the inner cash coffer of my bank safe. The bolts are mounted in T-iron bolt-bars, with suitable collars allowing them to revolve. The bolt-bars have the usual tails welded solid with them, and passing through a solid ring enclosing the cam. The cam has eccentric slots, in which the driving pins on the bolt-tails work, but these slots are continued concentrically with the cam, so that after throwing the bolts the cam can be turned without moving, thus bringing the solid block between the ends of the bolt-tails. The bolts of the lock shoot through the solid ring, so that the locks themselves are unaffected by any attempt to force the cam round. For such an attempt to succeed, the bolts of the lock must be sheared clean off.

Much ingenuity has been expended on locks

Fig. 3.



Chatwood's Changeable Key Lock.

which may be so changed by the owner as to unlock only with a changed key. The advantages of such locks are obvious, because if a key be lost or stolen, or copied, the lock can be at once changed to suit a different key.

Such locks have been usually very elaborate and costly. Diagram on the wall, No. 7, however, illustrates one which we have just patented, and which is simple and efficient. The levers have no gatings in their front edges, but have instead teeth, which gear with teeth on wheels mounted on a spindle. These wheels carry the gatings. The spindle on which the wheels revolve is capable of being moved away from the levers, so that the teeth are no longer in gear. If the key be now withdrawn, and a new key be inserted in the lock, and turned to its unlocked position, and the spindle be moved back into its former position, the wheels will be brought into gear with the levers in their new positions. The lock is thus altered to work only with the new key. The moving of the spindle may be effected in various ways, but I prefer to do it from the back of the lock, *i.e.*, the inside of the safe door. For this purpose I prefer to use a spindle with eccentric ends, one end projecting from the lock so that it may be turned round.

There are slots half through the cap and plate of the lock parallel with the path of the bolt, on which the spindle may move backwards and forwards, and slots at right angles to these in the other half of the thickness of cap and plate in which the eccentric ends of the spindle move. On turning this spindle it moves backwards and forwards, bringing the wheels into or out of gear with the levers; but it will be observed that this can only be done when the lock is unlocked, so that the lock cannot be altered or deranged except by some one possessed of the right key.

I have brought down, for the inspection of the members of the Society, one of my circular man-hole doors, which I have removed from the strong-room at the Glasgow Exhibition. This man-hole is carried by the strong-room door, and provides a second means of access in the event of accident to the main lockwork. There are several novel features in connection with this man-hole door which will be found interesting.

To locks which are unlocked without keys more attention has been devoted in America, France, and Germany, than in this country, though I cannot say with greater success. I refer to locks which are unlocked by turning a dial or dials to certain pre-arranged numbers or letters.

The advantage claimed for such locks is,

that they do away with the risk of keys being stolen or copied. On the other hand, the risks of forgetting the combination, and of being overlooked while unlocking the safe, are serious. Some years ago a demand sprang up for a lock which could be secure for safes, and at the same time opened without key, and it was owing to the impossibility of finding such a lock that I was led to design my patent combination letter-lock, shown on the table. It has four lettered dials on the outside, at the angles of a square, and these are connected by spindles to those parts of the internal mechanism which act the part of the levers of a key - lock. Each of the spindles is in two parts, held together by a spring clutch, which can be released by a key, passed through the centre of a disc carried by the inner portion of the spindle. The periphery of the disc is divided into a series of irregular inclines, which serve the same purpose as the step of a key—for raising the limb carrying the gating to the proper height to receive the main-stump. On pressure being applied to the main stump, when not opposite the gating, it is at once transferred to a solid part of the lock, leaving the lever free. The lock is provided with as many main-stumps as there are spindles. These main-stumps are carried by a disc, in which is a cam, for giving motion to the bolt, or keyhole bar. This disc is mounted upon the central spindle of the lock, and worked by a knob. Sometimes, instead of working the bolt by a cam in the disc, a recess is made in the periphery of the disc, and the bolt, or key hole bar, is then worked by a separate knob, which can only be moved when the recess in the periphery of the cam is opposite the end of the bolt, or keyhole bar, worked by the separate knob. There is a central knob, which unlocks the lock when the dials have been set to their right positions. The spindle of this knob is not rigidly connected to the internal mechanism, but is engaged with it by a spring clutch. If any attempt be made to turn the knob by force, the spring clutch releases, and the knob and spindle turn round without disturbing the mechanism. The principle of my "Invincible" safety lever is applied in this lock, so that if any attempt be made to feel for the right positions of the dials, the lock is blocked, in the same manner as the bolt in a key-lock. This lock combines the advantages of the ordinary dial lock, and also of being at the same time absolutely unpickable. The combination, or pre-arranged set of letters, may be changed by the insertion of a key from the back of the lock, which releases the dial spindles from the mechanism, and the dials may then be turned to a new set of letters, and the key withdrawn. This lock is very convenient in use, and is absolutely secure. It is the only English letter or numerical lock which has been extensively used for safes.

The American numerical locks are nearly all made with a single spindle. On this spindle one disc is fixed, and a number (two or three) of other discs are mounted loosely on the same spindle. These discs have pins in them so arranged that when the spindle has been turned one revolution, the pin in the fixed disc will come into contact with a pin on one of the loose discs, and cause it to turn. After turning two revolutions, a pin in this disc comes into contact with a pin in the second loose disc, and so on.

To unlock such a lock the spindle is turned in one direction a sufficient number of times to cause all the discs to move, and then turned to the number corresponding to the last disc. The spindle is turned in the opposite direction a sufficient number of times to cause all the discs but one to move, and then turned to the number corresponding to the next disc, and so on.

When all the discs have been placed in their right positions, a stump or detent of some form or other is free to fall into gatings on the edges of the discs, and to cause the spindle to engage with the bolt of the lock.

These locks are open to many serious objections, such as the time required in unlocking, the difficulty of changing the combination; many of them depend on the weight of some of their parts for their operation, and some of them almost require an expert to change the combination. I have not time to describe them in detail, but as such locks are used almost universally in America for safes, it is impossible to pass over them in the present paper.

There are a great variety of forms of time-lock, but they are all operated by clockwork, which removes at the pre-arranged time an obstruction, or blocking piece, from the path of the bolts. Generally two chronometers are used, so that if one should run down the other will perform the work. Thirty years ago I was requested by an English clockwork inventor to take the matter up, and perfect the crude invention submitted to me, but as I considered them not practically useful

to this country I declined. Yale, Sargeant, Dalton and others have perfected time-locks in America, at a cost to the user of £100 each, and in the present condition of American society, they are a necessity. Whenever our bankers desire their introduction, we shall have no difficulty in designing means of arranging for keeping keyholes closed against their own keys until the arrival of a prearranged time, without paying £100 for an American time-lock.

In conclusion, I would remark that, in the matter of locks and safes, England thoroughly maintains her position of superiority over other nations. English locks and safes, so far from being surpassed either in design or workmanship, are not even approached by those of any other nation. I regret that I have been able to give only such a brief outline of a subject which is of very great interest; or to treat of the general subject of safe and strong room manufacture, as having had the pleasure of designing the first steel strong room in the world, the subject has for me special interest. Time alone has compelled me to touch upon only one small branch of a very large and important subject.

I have been asked to state my opinion respecting the application of compressed oxygen applied with Mr. Fletcher's new blowpipe for the opening of safes, the danger of which I think has been enormously exaggerated. No doubt, used against sheet iron or ordinary boiler plates, this new instrument is very formidable, but the endeavour to fuse a number of holes in a mass of steel two or three inches thick is another matter, which I do not think has, or is likely to be, accomplished by any burglar with any quantity of compressed oxygen he can carry in a burglar's bag. I have not considered this subject as coming within the scope of my paper, and, moreover, I am placed in a difficult position, arising from the fact that the modes of defeating the instrument generally are subject matter of patents in their preliminary stages. I may say, however, that there are several ways of defeating the successful use of Mr. Fletcher's blow-pipe; the matter is simply one of cost only. It may interest the Society to know that I am at present building for one of our Lancashire banks a strong-room, which Mr. Fletcher will be invited to open by his burglar's appliances brought in his burglar's bag, merely being called upon to pay for repairing any damage his experiments may cause in the event of his failing to open the strong-room.

DISCUSSION.

Mr. J. EASTTY said one consideration in making safes was to make them fireproof, but this question he thought had now been solved. He congratulated Mr. Chatwood upon his various experiments and successes. He recollected many years ago a bank clerk telling him that he had opened the safe with a quill, and great was his relief when he found that he was able to lock it up again. He congratulated Mr. Chatwood, and other members of the same craft, that, with regard to the skilled labour employed, the sweating system would never be introduced.

Mr. H. CHUBB said with regard to the lock controversy which took place in 1851, Mr. Chatwood had referred to the picking of a Chubb lock, but whether it was picked or not, he (Mr. Chubb) was unable to say. He did know that Mr. Hobbs was invited by the Bank of England to go there and pick the Chubb lock, but he did not succeed in doing so. Since 1851 many improvements had been made in locks by different makers, including his own firm. The moveable stump had come out under many guises, but it seemed only to meet the difficulty half-way, because it was not until you began to exercise pressure that the part acted. He suggested that a lock should be made that would be absolutely resisting to all pressure of any kind. The stump of Mr. Chatwood's only came into action when pressure was applied, but in his opinion it should be on guard to meet the difficulty before it arose. With regard to the T-frame, and the description given of it by his firm, to which reference was made, he thought that this frame was used for some time before Mr. Chatwood took out his patent.

Mr. CHATWOOD said that was not so. He looked through the different patents, and the earliest he had been able to find was in the year 1865, whereas he took out his patent in 1862.

Mr. CHUBB said one modification of the T-frame was the overlapping of the front edge of the plate. The description given of this was not the same as that which had always been given. They had the open joint with the band all round, but where you have a projection you have a close butt joint coming over the edge of the plate. As to American locks, it was stated in the paper that they could not be obtained for less than £100. But he thought that this was not so. Mr. Dalton had invented a very good keyless combination lock, the motion being that of a wheel in which there were pins, but it had all the difficulties which had been referred to, that an expert was required to alter the combination. The mechanism consisted of a wheel in the centre of the lock. Three things could be done with the handle; by turning it to the right an arm was moved up and down, and by turning it to the left the wheel was moved round; if the lever was raised to the top the bolt could be drawn back, and by combining the two movements a third movement was obtained. The

position of the pins on the wheel corresponded to numbers on the external dial, which was divided into 100 divisions. To take away any of the combinations you merely raised a lever. It took a long time to open the lock when it was on the six combinations; in fact, he tried it, and it took him nearly a minute and a quarter, and, of course, such a lock would be very difficult to open in the dark. By putting in a different wheel the combination could be altered. That lock was certainly a superior form to the old stereotyped form. There were a good many varieties of keyless combination locks in America, where safes were in greater use than in this country, and where people had a great dislike to carrying keys. With regard to strong rooms, he thought it would be better if those requiring them would only patronise those of superior manufacture. In America, a room had recently been erected, having walls of $4\frac{1}{2}$ inches thick; the common thickness being usually $2\frac{1}{2}$ inches. He had examined some of the work, and could certify as to its excellent character. At one time, most of the steel plates used in their manufacture used to be imported from England, but now he believed they were made in Pittsburg. He thought there could be no employment which would afford a mechanical mind greater pleasure than that of lessening the risk of fraud by devising combinations, and keeping the burglar out. He was almost sorry that they had not a better class of burglar to deal with, as if they had, the contest between him and the safe maker would be more interesting. He was inclined to claim for the diagonal bolt some advantages, one being that when the bolts were drawn in, they were quite flush, and there was not the likelihood, that there was in others, of the coat of the person who opened the safe being torn by the projecting bolts. He strongly advised all intending patentees, before taking out a patent, to be careful to look at existing patents.

Mr. KAYE said he had not had much experience in making safes, but he had had a very large experience of making fastenings for nearly every kind of door, such as railway carriage doors, safety locks for carriages, and the like, which had met with great success. If anyone would come to his place in Holborn, he believed he could show fastenings which had advantages over any others.

Mr. D. CHADWICK said although he was not a ock maker, he had been an amateur engineer for 30 years, and could understand the enthusiasm with which Mr. Chatwood and Mr. Chubb devoted attention to this matter. He was old enough to recollect the praise bestowed on Bramah, Hobbs, and others. He had experience of strong rooms, unpickable safes, safes that were not to be exploded by dynamite or gunpowder, but what occurred to him was this, that the persons who used these excellent safes were only one in 10,000, and that if men like Mr. Chatwood would only devote their attention to cheapening the cost of good safes the demand for them would be considerably increased. To achieve success they must aim at improving upon the best, and must defy the most expert burglar. He should like to have a safe in every room, but at present he could not afford this owing to the expense. It was interesting to hear manufacturers say they would show the best lock for any purpose when at the present time a proper safe lock for railway carriages had not even been introduced. It was a stupid thing that every person who got out of a railway carriage should have to leave the door open. He had lately seen a self-fastening lock, which was a good thing in its way, and why it had not been brought into general use he could not understand. The object of the Society of Arts was to disseminate information, not especially technical information, but information which would result in the practical fact that persons would get the very best safes and locks at the cheapest possible rate.

Mr. CHATWOOD, in reply, said with regard to the remark about the moveable stump, Mr. Chubb seemed to regret that in order to bring that into effective work it was necessary to put pressure on, but this had been prevented in the beautiful lock made 35 years ago by Lord Grimthorpe. Whenever the key was put into the lock, or any instrument for the purpose of feeling the gatings, the bolt was blocked, and the main stump was away from the face of the lever a considerable distance, so that it was utterly impossible to pick it by the tentative process. The very thing which Mr. Chubb said should be done was done by Lord Grimthorpe some thirty-five years ago. With regard to the overlapping joint of the T-frame, it was quite true, when he first invented it, he did not contemplate the overlapping joint. Long before Mr. Chubb took out a patent for this, he (Mr. Chatwood) had done so, and the records of it would he found in his blue-books lodged in the Patent-office. He did not like diagonal bolts, and had avoided saying anything in the slightest degree offensive about his competitors, and had he not been challenged, he should not have said anything about them. So far as his information went, he knew the ultimate strength of the diagonal bolt was the driving pin which drove it up; that being so, it was essentially weak. It was not a claw-bolt, and he did not approve of it, as there was an element of weakness rather than of strength about it. Then Mr. Chubb had intimated that the cutting of the T-frame for the purpose of allowing the projecting claw to pass weakened the T-frame; and no doubt that was so, if you had no claw upon the bolt; but the holding power of the claw fitting into the dovetailed groove of the solid web was a great deal stronger than the wedge backed by a sledge hammer, one man following another until they were exhausted. That plan was tried at the Paris Exhibition of 1867, and it was found that the claw-bolt imparted a greater strength than the T-frame had without it, and it was not until all efforts to break open the safe

had failed, that the side-plates were cut away, by cold sets, and boiler-breaking appliances.

The CHAIRMAN said he was a little in the condition of Mr. Kaye, namely, of having paid a great deal of attention to locks, but very little to safes, so that he could only speak on safes according to the evidence laid before him. He had read the official account of the trials at Paris, between Mr. Chatwood and some American safe-makers, and was very much struck with this—that, although these trials ended in a kind of abortion, by the judges of the two nations being dissatisfied with each other, in the proceedings which went on, and certain irregularities taking place, so that the courts annulled the whole proceedings—still, the evidence remained, from which it appeared that the Chatwood safe was not broken into from the front, but from the back. As the back of safes in any good building was built in, it was not a very likely place for a burglar to break through. A casual trial under those circumstances did not represent the state of things which bankers and others would contemplate, and require safe makers to provide against. Everything, of course, had its weak place, but taking the lock and safe together, there could be no doubt in the mind of anyone who read the proceedings which took place in Paris, that Mr. Chatwood's safe had much the best of it. There were other difficulties about the trial to which he would not now advert. He was thankful to Mr. Chatwood for having referred to the lock which he (the Chairman) had made and exhibited here, so long ago as 1853. When Mr. Chubb spoke of a moveable stump not acting without pressure, Mr. Chatwood at once said, "Why that is the very thing which your lock does." It certainly did do so. Not that he thought much of that, for it did not signify much that the moveable stump did not come into action until it was wanted to come into action. He was reminded that many years ago Messrs. Chubb made what they called the "detector." Nearly 60 years ago this lock was a novelty, and he saw it, as a boy, exhibited in the Lowther Arcade, but even then it struck him that the celebrated detector, the name of which made its fortune, did not prevent the lock being opened, but merely showed that someone had been trying to open it. But then it could be put back, so that it was really no detector at all. Whether it was successful in preventing lock picking or not, it was certainly successful in advertising the makers. Long afterwards Mr. Hobbs declared that the detector was actually a help to picking by his method. He was surprised to hear Mr. Chubb say that Mr. Hobbs was invited to the Bank of England, and failed to open the safe; his recollection was slightly different, and he knew that the result was that the Bank of England took up Hobbs's lock. He was invited to write an article on locks for the "Encyclopædia Britannica," about 1856, and having seen, among other makers, Mr. Chubb, he was shown a lock which Mr. Chubb stated would beat Hobbs, and could not be overcome by what was known as Hobbs' method of tickling. Having looked at the lock a short time, he proceeded to operate upon it with a screw driver, when the lock flew open. Mr. Chubb was very much surprised at this, and asked him whether he could open the lock again, which he did, and then asked Mr. Chubb if he still wished it to be described in the Encyclopædia. The result was what might be supposed. The Encyclopædia was silent about it, and so was the re-issue of his "Clocks and Locks," in a peparate volume. With regard to "changeable" locks, there was one which had not yet been noticed, viz., Hart's, a very great simplification of Hobb's, or rather Newell's paraptoptic lock; but it was impossible now to describe it, or to compare it fairly with Mr. Chatwood's. Mr. Chadwick had asked why Mr. Kaye, or somebody else, did not invent a safety lock for railway doors. He could vouch for it that Mr. Kaye had done so, and that his railway locks were an immense comfort on the Great Northern and some other lines. He entirely agreed with Mr. Chadwick about the nuisance of the common railway door locks. When a person got out of a railway carriage, he must either stay behind and lock the door, or be very rude, and leave it unlocked. Mr. Kaye's carriage-lock fastened by merely pushing the door enough to keep it to, leaving the porters to lock it further if they like. Its facility of shutting was far beyond any others he had seen. Mr. Chadwick had also stated that there were very few people who used first-class safes, and it was desirable that they should do so, and Mr. Chubb was quite right in talking of the competition in producing first-class safes. Some people valued their diamonds in their safe very highly, while others valued the chance of keeping their money at a still higher sum. These were things as to which hard and fast rules could not be laid down. He was very glad to see the great improvement which had been made in the size of safe keys, for he could recollect the time when they were of an enormous size, while now they were as small as an ordinary latch key. In conclusion, he proposed a hearty vote of thanks to Mr. Chatwood for his able and interesting paper.

Mr. CHATWOOD stated that he had made a large number of the railway carriage door safety locks for the past 20 years, amounting to some 100,000 safety locks.

The resolution was passed unanimously, and the meeting adjourned.

Correspondence.

PANAMA CANAL.

My attention has been called to No. 1,846 of the *Journal of the Society of Arts*, in which is published a paper read before the Society on the 27th

March last, by Mr. J. Stephen Jeans, on "The Panama Canal and its Rivals." In that paper, and the subsequent discussion, mention was made of the existence of an "Atlantic and Pacific Ship Canal Company." Such a company have no legal existence; a Nicaraguan corporation with that name (whose property was sold for the payment of its debts) ceased long ago, and the only legal concession now existing is the one granted to Mr. Menocal, in April, 1887, acting on behalf of the "Nicaragua Canal Association," of New York. Under this concession, the company, which has been incorporated by the United States Senate, has begun operations in Nicaragua. As it may save misunderstandings which might be prejudicial to third parties, I beg to make this rectification.

J. F. Medina,
Minister of Nicaragua in France.

Legacion de Nicaragua, 56 Rue Bassano, Paris.
April 30th, 1888.

DRAWING, A MEANS OF EDUCATION.

Fifty years ago—say, in 1838—when the Society for Promoting Practical Design was engaged, by means of its own schools, in Leicester-square and Newton-street, in reforming the Government School of Design at Somerset-house, which was effected for the time, the teaching of children was considered and inculcated. In our school we had children of five years old drawing well from natural objects.

The principle, then, laid down by competent authorities was, that, for carrying out the first or main object of Mr. Ablett, the young child or infant, single or in a group, should be set to study from nature—a turnip, or a potato, and not from models and drawings. It was known then that the training of the eye and mind begins with the gradual observations of nature. The swimming with models, casts, geometrical forms and rules, is not only needless, but mischievous.

There is a proper, and later period, when such expedients may be resorted to, but in the year 1888, if it had not been for the many retrogade influences of South Kensington, we should not have to argue the method, nor have remained without its general and proper adoption.

Hyde Clarke.

32 St. George's-square, S.W.

Mr. W. G. Trewby writes:—"I am erroneously reported as saying, 'children should only be taught their own language.' On the contrary, I advocated the teaching of elementary drawing, which one speaker said served as a 'language' in foreign countries (by rough sketching) when ignorant of the tongue. But I added, I feared if drawing were a subject for the Government grant children would be forced up to a standard, and then the cry of over-pressure would be heard."

Obituary.

Leone Levi.—Dr. Leone Levi, who died on Monday night, 7th inst., after a long illness, was a member of the Society for nearly thirty years (1854-83), and in 1854 he was awarded the Swiney Prize for his work on the "Commercial Law of the World," published in 1850. He also read several papers at the meetings of the Society. He was born at Ancona, in 1821, and came to England when a very young man. He mastered the English language, and devoted much time and energy to the organising of chambers of commerce, and making known his views on public questions. The Liverpool Chamber was founded in 1849, and similar institutions were afterwards established in other commercial towns. In 1852 he was appointed to the Chair of Commercial Law in King's College, London, a post he filled for many years, more especially in connection with the evening classes, which he was a chief means of establishing in the college. Dr. Levi was also an active member of the Council of the Royal Statistical Society, contributing many papers to its journal, more especially bearing upon the industrial occupations of the people. It was Dr. Levi's suggestion of the utility of an international commercial code that caused the passing of the Acts thirty years ago, whereby the mercantile laws of the United Kingdom were made uniform on many points. To him also is due the annual publication of Judicial statistics for the United Kingdom. Professor Levi was called to the Bar at Lincoln's-inn in 1859, and was created a Doctor of Political and Economical Science by the University of Tübingen in 1861. Some years since he laid the foundation of a library at Ancona for promoting technical education.

J. C. Morton.—Mr. John Chalmers Morton, editor of the *Agricultural Gazette*, died on Thursday night, the 3rd inst., at his residence, Holmleigh, Harrow. He was born in 1821, the son of Mr. John Morton, agent, for upwards of fifty years, of the Earls of Ducie, on their Gloucestershire estate, and a nephew of the celebrated Dr. Chalmers. He was educated at Merchiston Castle School, Edinburgh, and afterwards at the University of Edinburgh. He came to London in 1844, and undertook the editorship of the *Agricultural Gazette*, in which position he continued until his death. He brought out, in 1855, the "Encyclopædia of Agriculture," and for six years he served, with Dr. Frankland and Sir William Denison, as one of the Royal Commission for Inquiry into the Pollution of Rivers. Mr. Morton was elected a member of the Society of Arts on the 10th March, 1847, and since that time he was in the constant habit of contributing to the Society information on agricultural subjects. His last paper, on "Agricultural Education," was read on May 4, 1887. The Society awarded him a silver medal in 1880, for

his paper, "Agricultural Experience—the Lessons of Forty Years." He also acted as Examiner in Agriculture. It has been said of Mr. Morton, that "throughout a long and varied career, he secured the confidence and good-will of all whom he encountered."

General Notes.

INSTITUTIONS DE PREVOYANCE.—The third session of the Universal Scientific Congress of the Institutions de Prévoyance will be held in Paris from the 3rd to the 8th of July, 1889. The first session was held in 1878, and the second session in 1883. These Congresses are arranged by a permanent Association, consisting of Honorary Presidents (MM. Jules Simon, De Lesseps, Carnot, Leon Say, and others), thirty foreign presidents, sixty foreign vice-presidents, 400 foreign members, and 300 French members. The General Secretary is M. Augustin Chauraud de Malarce, and the office in Paris, 68 Rue de Babylone.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MAY 16.—"Electric Lighting from Central Stations." By R. E. B. CROMPTON. THE ATTORNEY-GENERAL, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 15.—"Duty of the State towards Emigration." By JAMES RANKIN, M.P. J. G. COLMER will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 29.—"Persian Textiles." By CECIL SMITH.

The above dates are liable to alteration.

CANTOR LECTURES.

The Sixth (and concluding) course is on "Decoration." By G. AITCHISON, A.R.A. Three Lectures.

LECTURE III.—MAY 14.—Stained Glass.—Enamels.—Woodwork, including Carved, Turned, and Inlaid.—Woven and Felted Fabrics.—Leather: Embossed, Painted, and Lacquered, and Cuir Bouilli.—Imitations of, and Substitutes for, Leather.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. Aitchison, "Decoration." (Lecture III.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieutenant F. E. Younghusband, "A Journey across Central Asia, from Manchuria and Peking to Kashmir over the Mustagh Pass."

TUESDAY, MAY 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. James Rankin, "Duty of the State towards Emigration."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Gardiner, "The Plant in the War of Nature." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. Peter Crawford Barlow's paper, "The Tay Viaduct, Dundee," and on Mr. W. Inglis's paper, "The Construction of the Tay Viaduct, Dundee."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Charles Booth, "Condition and Occupations of the People of East London and Hackney, 1887."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. R. Bowdler Sharpe, "List of a Collection of Birds made by Mr. L. Wray in the Range of Mountains of the Malay Peninsula, Perak." 2. Prof. F. Jeffrey Bell, "Descriptions of four new Species of Ophiuroids." 3. Mr. H. Seebohm, "Remarks on some rare Species of *Phasianus* from Central Asia."

WEDNESDAY, MAY 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. E. B. Crompton, "Electric Lighting from Central Stations."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. M. Whipple and Mr. W. H. Dines, "Report of the Wind Force Committee on Experiments with Anemometers conducted at Horsham." 2. Mr. William Marcet, "The Measurement of the Increase of Humidity in Rooms, by the Emission of Steam from the so-called Bronchitis Kettle."

Pharmaceutical, 17, Bloomsbury-square, W.C. 11 a.m. Annual Meeting.

Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. First Summer Exhibition.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, MAY 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, 8 p.m. Profs. Meldola and F. W. Streatfield, "Researches in the constitution of Azo and Diazo Derivatives—IV."

Parkes Museum of Hygiene, 74A, Margaret-street, 5 p.m. Mr. L. R. S. Tonalin, "Healthy Clothing."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemical Arts." (Lecture VI.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Reply of Mr. R. E. Crompton to discussion on his paper, "Secondary Batteries *versus* Transformers."

Historical, 11, Chandos-street, W., 8½ p.m. Rev. W. Cunningham, "The Commercial Policy of Edward III. or Merchant Adventurers."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

FRIDAY, MAY 18...United Service Inst., Whitehall-yard, 3 p.m. Rear-Admiral P. H. Colomb, "The Naval Defence for the United Kingdom."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. M. Alphonse Renard, "La Réproduction Artificielle des Roches Volcaniques."

Philological, University College, W.C., 8 p.m. Address by the Rev. Prof. A. H. Sayce, President.

SATURDAY, MAY 19...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "The Later Works of Richard Wagner." (With Vocal and Instrumental Illustrations.) (Lecture VI.)

Journal of the Society of Arts.

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FRIDAY, MAY 18, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor G. Aitchison, A.R.A., delivered the third and concluding lecture of his course on "Decoration," on Monday evening, 14th inst.

The lecture was illustrated by specimens of wood-carving, embroidery, and woven stuffs, lent by Messrs. Morant, Boyd and Co.; of lacquer panels and bronzes by Messrs. Liberty and Co.; of paperhangings by Messrs. Woollams; of paperhangings, embossed leather, and leather paper, by Messrs. Jeffrey and Co.; of old embossed leather, painted textiles in lieu of paperhangings, and leather paper, by Messrs. Fisher and Co.; of parquetry by Messrs. Steinitz and Co.; of inlaid woods, &c., by Messrs. Mitchell and Hendry; of modern enamels by Messrs. Simpson and Co.; and of stained glass by Messrs. Clayton and Bell.

On the motion of the Chairman, a cordial vote of thanks was passed to Professor Aitchison.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

CANAL CONFERENCE.

Thursday, May 10th, 1888, Sir Douglas Galton, K.C.B., F.R.S., Chairman of Council, in the chair.

The first meeting of the Conference on Canals and Inland Navigation was held on Thursday afternoon, at 2 p.m., when the Chairman delivered an address, after which the following papers were read and discussed:—

1. "Canal Engineering; its Past; its Present Aims; and its Prospects in the Future." By Leveson Francis Vernon-Harcourt, M.A., M.Inst.C.E.
2. "History, Rise, and Progress of Canal and River Navigation in Great Britain and Ireland." By M. B. Cotsworth.
3. "History of the Rise and Progress of Waterways and Railways in England and Wales, and their Mutual Influence upon each other." By Urquhart A. Forbes.
4. "Notes on the Maintenance of Canals, with special reference to Mining Districts." By G. R. Jebb, M.Inst.C.E., Engineer to the Birmingham Canal Navigation, and to the Shropshire Union Railways and Canal Company.
5. "Inland Navigation in Great Britain." By Edward John Lloyd, M.Inst.C.E., Engineer and Manager of the Warwick and Birmingham, and Warwick and Napton Canals.
6. "Present Condition of Inland Navigation in the United Kingdom, with suggestions for its Improvement." By M. B. Cotsworth.

Friday, May 11, 1888; Sir Douglas Galton, K.C.B., F.R.S. (followed by Colonel A. C. Hamilton, R.E., member of Council), in the chair.

The second meeting was held on Friday afternoon, at 2 p.m., when the following papers were read and discussed:—

1. "Inland Transport in the Nineteenth Century by Land and Water." By Francis Roubiliac Conder, M.Inst.C.E.
2. "Transport by Canals and Railways." By G. Lester.
3. "The Improvement of the Water Communication between London and Birmingham." By Henry J. Marten, M.Inst.C.E., Engineer to the Severn Commissioners.
4. "Canal and Inland Navigations properly National Works." By General Rundall, R.E., C.S.I.
5. "The Capabilities of the River Severn as an Inland Navigation." By Henry J. Marten, M.Inst.C.E., Engineer to the Severn Commissioners.
6. "The Kennet and Avon Canal." By H. Gerrish.
7. "The River Weaver Navigation." By J. A. Saner.
8. "Continental Waterways." By W. J. C. Moens.

9. "Improvements in Canal Communications." By Samuel Lloyd.

10. "The Law of Canals." By A. B. Kempe, M.A., F.R.S., Barrister-at-Law.

11. "Inland Transit—a New Departure." By W. Martin Wood.

In the course of the proceedings the following resolution was passed:—

"That the Legislature should seriously consider the necessity of encouraging and assisting the improvement and extension of the canal system by State acquisition or otherwise; and that meanwhile this Conference urges the Council of the Society to petition the House of Commons for the amendment of the Railway and Canal Traffic Bill, by authorising local authorities to constitute public trusts for the development of the existing system of canals."

This resolution is now under the consideration of the Council of the Society.

The publication of the papers and discussion will be commenced in the next number of the *Journal*.

FOREIGN & COLONIAL SECTION.

Tuesday, May 15th, 1888; J. G. Colmer, Secretary to the High Commissioner for Canada, in the chair.

The paper read was—

DUTY OF THE STATE TOWARDS EMIGRATION.

By J. Rankin, M.P.

The subject of emigration, upon which I have been invited to say a few words to you this evening, is one which may be regarded from various points of view; but, as I imagine that those whom I have now the honour of addressing are not themselves likely to be emigrants, I propose this evening to treat the question more from the point of view of its relation with the State, and with the method which might be applied by the State in a system for directing and aiding emigration, rather than from the point of view of instruction or advice to the intending emigrant.

I would first of all, however, direct your attention to the fact that, from the very earliest times, emigration has been the natural and constant method for disposing of the surplus population of any country, and that in olden times, when the vast areas of the Old World were either unpopulated or very sparsely peopled, the emigration movement was simply an extension of boundaries from time to time, so that no distinct line of demarcation existed between the old and new settlements; and it was not until the countries of Europe became fully settled, and in some cases over-populated, and when no new lands contiguous to the old countries were available for settlement, and it became necessary to find new homes across the ocean, that the term "emigration" assumed a more distinct meaning than it had hitherto borne. But the cause, and to a great extent the process, of emigration in the present day is precisely the same as what it always has been since the world began, and it is only the carrying out of the very ancient commandment to "Be fruitful, and multiply, and replenish the earth."

I trust, therefore, that it may be fully understood that there is nothing new whatever in putting forward emigration as the natural remedy for over-population. It may be said, perhaps, that the commencement of the era of modern emigration took place in the last decade of the 15th century, when Christopher Columbus discovered America, and Vasco di Gama the passage round the Cape to the East Indies; but it was very many years subsequent to those great discoveries before any systematic emigration took place, and, indeed, for a couple of centuries after that colonisation partook more of the character of conquest than of settlement.

The colonies were looked upon by the countries that obtained them far more in the light of possessions, out of which the greatest possible amount of treasure or wealth should be extracted for the benefit of the mother country, and little or no thought was given to the welfare or advantage of the colony itself, and the treatment of the colonies was never such as to make the colonists feel that the old country still regarded them as a portion of its people; and the result was, that in the case of nearly all the great colonising countries, such as Spain, Portugal, Holland, and France, the colonies parted company with the mother countries as soon as they had the power to do so. Great Britain also lost the United States, and might have lost her other colonies had not wiser counsels prevailed in the method of treatment of her colonies. The proper way to regard our colonies should be to look upon them as only extensions of the mother country, and to treat the colonists, as far as circumstances permit, in exactly the same way in which subjects are treated in the old country; and to maintain, as far as possible, a continuity of

interest and affection in the minds of both the dwellers in new and old countries. Having arrived now at the conclusion that emigration is the natural and effective method of dealing with a surplus population, I would venture to direct your attention for one moment to an important economic truth, which is, that the three essential factors in the production of wealth are "Land," "Labour," and "Capital." All these three factors we have in plenty within the British Empire. We have the land in the colonies, and we have the labour and capital in the old country, and the problem which those interested in emigration are desirous of solving is how to bring these three factors together.

Now, the question I want to deal with to-night is—Should the State interfere in any way in assisting or aiding in the solution of this problem, or should it entirely stand aloof and allow the work to be wrought out by independent agency? And I propose to try the question by applying three tests, which are:—

1. Is such an interference by the State right in principle?

2. Is it necessary or expedient?

3. Is it practicable?

1. With regard to the first of these test questions, I would say that if it were the accepted rule and law of the land that no assistance or relief whatever was to be given to any individuals, whatever the conditions or whatever the circumstances of their life might be, then it would be difficult perhaps to establish the argument of principle in asking for assistance towards the work of emigration; but as long as the law recognises, as it does recognise, that poverty and starvation must be relieved, and as long as nearly ten millions a-year are spent upon the maintenance of our workhouses and in relief of our paupers, it is impossible to contend that such is the doctrine of the State; and although many persons are of opinion that our present Poor-law is by no means the wisest or best for fulfilling its objects, yet I have never met a single individual who advocated the entire abolition of all kind of Poor-law. Again, we find that in the case of visitations by famine, such as occur from time to time in India, the Government has thought right to step in and vote large sums of money for the support of the sufferers. Again, we find that in the case of Ireland and in the case of the Highlands, Parliament has voted sums of money as assistance to emigration itself. I would also draw attention to the proposals which are contained in the new Local Government Bill, which clearly embodies the principle that it is right and just to assist emigration by public money, although it throws the responsibility and burthen of raising and applying such money upon local authorities rather than upon the central Government, a step which, in many ways, I look upon as wise and politic, though I hope it may not result in a want of further action on the part of the Imperial Government; and what I would now maintain and ask you to believe is this—that if we consider that the State should spend large sums of money in maintaining persons who have arrived at a state of pauperism, it is surely better the State should spend some of its money in preventing pauperism rather than in maintaining it. Although it was not spoken with regard to the question of emigration, I would like to quote a passage in a speech of Mr. Gladstone's, which appears to me very applicable to the question we are discussing. On November 28th, 1882, Mr. Gladstone spoke as follows:—

"I will take a hypothetical case as an illustration; let me suppose that in some county in Ireland there were, happily, a discovery of vast mineral wealth, where the district was populated very thinly. Let me also suppose that in the neighbouring counties or districts, at a certain distance, there was a very large surplus population. What should we think of a state of law, or a state of usage, which prevented you from bringing that surplus population to work the mineral?"

Applying the same reasoning to the subject of emigration, we may well ask what will be thought of us if we allow a great mass of unemployed persons to drift into a condition of abject poverty, when, by a proper and judicious scheme of emigration, these people might be placed where they could earn a good and honest living, and become a blessing to the country instead of a burden?

Look, again, on the other hand, to the action of the Colonies in this matter. We find they have from time to time spent large sums of money in importing labour, or, in other words, in encouraging immigration. I find that, for some years back, an average annual amount of £877,000 has been voted and spent by our self-governing Colonies for the purposes of immigration. This money, it is true, has been spent for the purpose of getting labourers to do work for the benefit of the colony, and, no doubt, had no immediate reference to the welfare of any particular immigrant; but my con-

tention is—if it is a just and proper expenditure by the State to import individuals into a country for the sake of improving the condition of that country and developing its resources, it is still more the duty of a country to assist in emigrating its people when those people are unable to find employment and sustenance in that country, and who are certain before long to become a drag and a burden upon their country.

And it has this additional reason for being put into operation, namely, that in the latter case great benefit accrues to the individual as well as to the State; whereas in the former case, although benefit does or may accrue to the individual, it is an incidental circumstance, and one which was not the motor cause for the expenditure of money.

It therefore appears to me that the case is much stronger for the State to spend money upon emigration in an over-populated country than it is for a State to spend money upon immigration in a sparsely-populated country.

On account of the foregoing consideration, it appears to me that an expenditure, of course wisely and carefully administered, for the purpose of emigration is a perfectly legitimate principle for any State to apply when the circumstances of its population seem to demand it; and I contend that this is so, even when it is an expenditure to which there would be no repayment; but the case becomes infinitely stronger, from a purely public-purse point of view, when it is probable, and may be certain, that the advance can be made in the shape of a loan rather than a gift; and when it becomes apparent that the operation is one which is both financially sound as well as philanthropic, it appears to me to leave no room for doubt as to whether the principle is just or not.

2. I now pass on to the second consideration, namely, is it necessary or expedient? And I would here remark that the enormous increase of our population between the censuses of 1871 and 1881, which was at the rate of 1,000 a day, renders it absolutely necessary that some very considerable occupation must arise, if work is to be found for the increased numbers.

Taking the figures of the Registrar-General or last year, it would be found that England and Wales, with the exception of Belgium, is the most densely-populated country in the world, and taking the whole of the United Kingdom, and comparing the cultivated area with the population, it would be found there are only $1\frac{1}{3}$ acres to each head of population; and when we remember that the land of this country has been under cultivation for centuries, and that it is not probable that much of it remains uncultivated where it could be profitably cultivated, and also knowing that the average produce per per acre is greater in England than almost any other country in the world, it will be seen we cannot expect to have any material increase in the way of greater sustenance derived from the land.

On the other hand, the introduction and improvement in machinery, both in agriculture and in manufactures, has ever a tendency to decrease the amount of manual labour which is necessary to produce the same amount of material; and although it is true that the production of machinery itself employs a certain number of hands that would otherwise be occupied in agriculture or manufacturing labour, yet it is not the case that as many hands are employed in this industry as are displaced by the machinery so made, and therefore it is absolutely true that if our manufactures and other industries remain at about the same point of production as they have at present attained to, fewer, rather than more, hands will be required.

No doubt, however, a steady and gradual increase in the quantity of manufactures takes place, but at the same time nothing like such an increase as is necessary to absorb the increase of workers, and with the growing development of the trade of foreign countries, and the closer competition which this country has now to submit to, it does not appear likely that our trade will increase by such leaps and bounds as it formerly did, and, as far as I can see, no new industry is likely to arise which would absorb a large amount of labour; and once again, although the wages of our working classes are greatly improved, especially when the cheapness of provisions is taken into consideration, yet they are not such as could properly bear a considerable reduction.

From a return which I collected some years ago from a great variety of trades throughout the country, I found that the number of artisans who were constantly out of employment in nearly every trade was something like 5 per cent. of the number belonging to that trade, and a very much larger number were in irregular work.

Again, when we consider that even at the present time, notwithstanding the rigid administration of the Poor-laws, we have in round

figures one million of persons in the United Kingdom receiving relief, in some shape or form, from the poor-rate, it is apparent that the means of sustenance among large masses of our working people are very little above the limit which is required for the maintenance of life.

For these and other reasons, it appears to me, and I hope to you also, that some outlet for our ever increasing surplus population is an absolute necessity, and that it is wise and expedient that we should take advantage of and foster the natural method of settlement upon new lands.

I conclude this part of my subject by quoting the opinions of two professors of political economy. Mr. Mill says:—"Emigration is the safety valve of the labour market." Professor Rogers says:—"I am persuaded, from reason and experience, that the emigration of the young is the best remedy for hereditary pauperism."

Before passing on to the third part of my subject, I think this would be the proper place to notice the proposition which has been lately made with regard to what is called home colonisation, and I would here frankly say that if such a project were at all likely to be successful upon a large scale, nothing would give me more satisfaction, nor is there anything which ought to be assisted more liberally than such an undertaking. But I think a very short inquiry into this question will show that it can hardly be expected to produce any great results, because, in the first place, the cultivatable land, as I have already shown, is probably nearly all of it taken up in this country, at all events all the land which can be profitably cultivated; and when we hear of land going out of cultivation from not being capable of being profitably worked, it is not likely or probable that persons unversed in agriculture could make that land pay better than farmers who have been obliged to give it up; but the real fact is, that there is very little land in this country which is worth anything which has gone out of cultivation; much, no doubt, has been laid down to grass, and nearly all land is not so profitable as it used to be, but the returns do not show that land is actually going out of cultivation; in fact, the most recent returns connected with this subject show that there has been an increase of cultivated area in this country. In Ireland there has been a small decrease.

The amount of cultivated area in Great Britain was, in 1886, 32,591,217 acres, while in 1887, it was 32,615,304, thus showing an increase upon the total amount of 24,087 acres.

But the essential reason why such a scheme as home colonisation is not likely to succeed is in the matter of expense. The very cheapest land that would be worth the cultivation in this country would cost, for land alone, £20 per acre, and buildings would be extra.

On the other hand, the very best land in our Colonies can be obtained, either free, from the Colonial Government, or for a very small cost indeed—in the case of Canada 10s. per acre—that is to say, at $\frac{1}{40}$th of the cost which would be required for the purchase of land in this country. This difference of cost is the real and fundamental reason why, in my opinion, the scheme of home colonisation, on any large scale, must be regarded as an impossible one.

I do not, for one moment, wish to throw cold water upon the scheme, if there are persons sufficiently energetic to undertake it and make it succeed, but I cannot persuade myself that it can be an efficient remedy on a large scale for over-population; and, therefore, in arguing the question of emigration, I put it out of consideration as a practical remedy.

I would here remark, in passing, that I regard the extension of gardens, and the allotment system, in a very different way, and I look forward with hope to such extension being a means of enabling many labourers who cannot find full employment for wages, to be able to remain in the country, eking out their three or four days' wages by working in their gardens on the other days.

3. I pass on now to consider the third point, namely, "The Practicability of Emigration." With regard to the general question of the success of emigration, I would in the first place point to the position of our Colonies at the present moment, and ask you to consider the enormous development and success which has attended the settlement of these new countries. At the present time the white population of our Colonies numbers something like 8,000,000, and the export and import trade is about £380,000,000, and the income of each Canadian is £26 18s., of each Australian £43 5s., and of each inhabitant of the United Kingdom £35 4s.; so that the average income of the Englishman is about the same as that of the colonist; and as it is of course well known there are many more wealthy individuals in this country than in the Colonies, it will be obvious that the distribution of wealth is more even than it is at home, and the

generality of people are better off than the poorer classes in this country.

The position of the United States is also a conclusive answer to the inquiries as to the success of the settlement of new lands. I would also refer to the fact that, during the period the Emigration Board was in existence—namely, from 1840 to 1872—there was no less a sum than £17,786,463 remitted home by emigrants who had gone out from this country to various Colonies, and taken up what were then Crown lands, and although we have no return, as far as I am aware, of the amounts remitted since the abolition of the Board, yet it is perfectly well known that they are very large.

Again, I would draw your attention to the fact that in almost every one of our Colonies the Poor-law, such as they have, is hardly ever put into operation. So much so is this the case that very few people in the Colonies know that there is any such law on the point. Taking these facts into consideration, we cannot for one moment deny that our colonisation has been of a most successful character.

I have already alluded to the three factors necessary for the production of wealth, and the reason why such success has been attained in the past, and why we may look forward to similar success in the future, is mainly due to the fact that we have in our Colonies an enormous area of good and useful land.

At the present time the area in our Canadian and Australian Colonies is about 6,476,000 square miles, and the population upon that area is 7,250,000, showing very nearly an average of 576 acres to each person; of course this is the whole area, and some of it is not fit for cultivation. The proportion in England is only $1\frac{1}{4}$ acres to each head of population, and in the United Kingdom $2\frac{1}{6}$ acres per head. It will therefore be easily seen what an enormous surplus of one of the factors of wealth exists in the Colonies, and how easily this could absorb a vast amount of surplus population which we have in the old country.

It may be said, however, colonisation and emigration have so far been almost entirely of an independent character, and not assisted by the State. This is, of course, not accurately true, as I have already pointed out; but, nevertheless, it is, in the main, true, and what we have now to do is to investigate the question whether assisting emigration is likely to be made to pay.

There are three distinct kinds of emigration:—1. There is the adult independent emigration. 2. There is the child emigration, distinct from family emigration. 3. And there is the colonisation or settlement of emigrants upon the land.

I will say a few words about each of these different methods.

Firstly, with regard to adult emigration—It is manifestly easier and cheaper to simply pay a labourer's passage, and to let him take the chance of finding employment as a labourer or artisan, than it is to find the money necessary for developing a farm; therefore, it always has been, and always will be the case, that by far the larger portion of persons who emigrate will be those who have but little capital of their own, and simply go out to seek work as labourers or artisans.

With this class of emigrants it is difficult to recommend assistance with the hope of having it repaid, as the means of obtaining repayment from an emigrant having no attachment to the soil, and having no property of his own except what he may chance to save out of his wages, are not easily to hand; and it also labours under the great disadvantage that the labourers and artisans at present in the Colonies, and whose political power is, as we know, very great, do not look with favour upon the introduction of new labour, fearing that it might to some extent interfere with their rate of wages; and hence, it would be difficult for this country, upon any large scale at all events, to undertake assisted adult independent emigration.

A good deal, however, may be done in this way, by persons in various localities, who may know the individuals to be emigrated, and who may have sufficient reliance upon their uprightness and honesty to be able to advance them money to pay their passages, and who may arrange that they are sent direct to some one or other who may be known to the sender of these emigrants, and who would be able to make a reduction from the wages of the emigrant, in order to repay the sums advanced.

As far as repayment is to be obtained by legal enactments, it should be the duty of both this country and the Colonies to facilitate such advances and such repayments. I do not, however, think it would be prudent or politic for the State to undertake the operation of giving free passages with any good hope of having much repaid. I have myself, upon a small scale, tried this experiment, and I regret to say that the results were not quite so satisfactory as I could have wished.

It might, however, be the duty of the State,

in cases of emergency, to grant free passages to some of our Colonies, and, in any case, I see no reason why our Government should not do as Colonial Governments in times past have done, and give assistance, at all events, to proper and suitable persons who were leaving these shores, without any expectation of repayment whatever.

In this connection I would mention with gratitude that the Government, two years ago, yielded to the urgent appeals from the Central Emigration Society and others connected with this work, and established a most useful office, under the name of the Emigrants' Information Office, at 31, Broadway, Westminster, an office under the general control of the Colonial-office, but supervised and managed by an independent committee. The usefulness of this office has been very great, as it has, in a most impartial manner, given trustworthy and reliable information gratis to any inquirer, and has enabled workmen in the country to ascertain the rate of wages and the demand for workers which may exist from time to time in different parts of the Colonies. This institution I regard as a first and important step in the recognition by the State of its duty of directing emigration.

On the whole, as far as this class of emigration is concerned, I would like to see our Government giving assistance, to some moderate extent, by way of assisted ocean passages, but I do not see how it would be possible for them to advance money with the hope of its being repaid.

I pass on now to the second method, and which is of a very hopeful character, and that is the emigration of young children who are at the present time maintained either by the State institutions or in voluntary and charitable homes. There are three agencies at work here: First, the wholly State agency of the Poor-law. Second, the partially State and partially voluntary agency of the reformatory and industrial schools. And third, the wholly charitable agency of voluntary homes.

Now, with these three classes of agency a great deal might be done, and a good deal, it is true, has been done; but a great deal more might be done in fostering this excellent work, and the problem to solve in this question is to enable the wholly State agency to put its legal powers, which are considerable, into action through the assistance of the two agencies, which are partly or wholly of a philanthropic character.

The success of this movement has been of a most gratifying character, and the accounts given by every worker in the matter of child emigration point to the fact that the number of failures amongst children so emigrated rarely amounts to 5 per cent.

I would venture to point out that this child emigration is at once the most beneficial and hopeful method of disposing of a destitute child, and at the same time the cheapest and most economical method for the State in dealing with it.

In the first place, the child is taken away from the possibility of an immediate return to its old haunts or its dissolute associates, and it is placed in a country where the demand for its labour is great, and where it is certain to find employment if it behaves itself; and on the other hand, the emigration of the child is far less costly than its maintenance in the workhouse or in a voluntary home.

The legal powers of the Board of Guardians in this matter are almost as great as the necessity of the case requires, but there are serious difficulties in the way of the Guardians of the Poor in carrying out the work directly, and, therefore, it has been in the past, and will be in the future, of high importance that there should be other agencies ready to undertake the active work of conveyance, and settlement of the child to its new home.

Such agencies, happily, do exist, and I rejoice to say, increase from year to year, and it is to this voluntary agency, carried on by persons who are deeply interested in the movement, who are acquainted with the Colony, and have receiving houses in the Colonies, that we must look to for the actual carrying out of the work. The Guardians have the power of the purse, voluntary agencies have the power of knowledge, and therefore these two classes of institutions should be supplementary to one another.

I am happy to say that the State, under its present Government, has thought fit to recognise the desirability of the work, and has given facilities for such transfer of the child as I have before alluded to, and has arranged with the Colonial Government to have a proper inspection of the children made by a colonial agent, and, on the whole, the reports of these agents have been of a very satisfactory nature. The number of children, however, who have been hitherto sent from unions in the United Kingdom has been exceedingly small, and amounts to only a few hundreds.

Glancing briefly at the other class of schools for destitute children, we find in that list the reformatory and industrial schools. Now it

must be known, no doubt, to those that I am now addressing, that a distinction exists between the class of child taken in at the reformatory and industrial schools. In the former, children to be sent there by the magistrates must have committed some offence, and have endured some term of imprisonment; whereas in the latter case children may be sent who have not been convicted of crime at all, but who may be in a position to be likely to be led into crime. Thus we see the broad distinction between the two classes of institution is that one is for reform, and the other for prevention; and although I acknowledge to the full that the reform attained in many of these reformatory schools is of a most complete character, and that boys and girls turned out from them are in many cases useful and upright members of society, yet it is undeniable the Colonies are now beginning to regard with distaste the introduction of persons from this country connected with the criminal classes, and therefore I, myself, would doubt the wisdom of urging upon the Government the idea of making State provision, or giving State money for the purpose of assisting and encouraging emigration from reformatories. At the same time, I hail with satisfaction the fact that a large number of these boys have been emigrated by independent methods, and have done exceedingly well, and I hope no relaxation of energy of reformatory managers in this direction may take place.

With industrial schools the case is, as I said, on a different footing; and here, I think, both as to the class of children being generally destitute and often without parents, and in many cases with parents who are worse than none, and also as to the training received in these schools, there are no more proper institutions to receive assistance from the State with a view to encourage emigration, and I trust that, in the forthcoming legislation which is promised upon the industrial schools, we may find the Home Secretary has embodied a proposition which he has had made to him by the Central Emigration Society, and approved of by the greater number of managers of industrial schools, namely, that the unpaid portion of the grant receivable by these schools from Government for committed cases might be received as a capital sum, and devoted to the emigration of any particular child or children whose cases were found to be suitable by the managers and the Home Secretary.

This power of disposing of their children would be very valuable to managers of industrial schools, and one which, by the check of the inspection by the Home-office, could not be abused. This proposition would not cost the nation any more than it now costs them in grants made towards industrial schools, and it would be at the same time both economical and beneficial to the child.

There are many other matters of detail with regard to the interposition of the State in this question of child emigration that might be referred to, but I feel I must not dwell longer on this part of my subject, and I would only add the remark that I think the highest thanks should be given by all who are interested in this question of the decrease of pauperism to the great and philanthropic efforts which have been made in this particular direction by the managers and teachers in reformatory and industrial schools and voluntary homes.

I now come to the third and last kind of emigration, which may be called colonisation, and which is the settlement of emigrants upon the land. This is, from a State point of view, perhaps the most important of the three kinds of emigration, and it certainly is the one which requires the largest capital to carry it out, and at the same time is one which meets with little or no opposition from the Colonies.

At the present time nearly all the Colonies make free grants of land, in varying quantities, to persons who will undertake to settle upon the land, and bring a certain amount into cultivation, and put up a certain amount of buildings. To do this, however, requires some capital, and, therefore, without assistance, colonisation is beyond the reach of the ordinary emigrant, who most frequently is penniless or nearly so, and, therefore, it is with regard to this particular kind of emigration that it is necessary that capital, from some source or other, should be forthcoming.

It is of course the fact that, from year to year, large amounts of private capital are invested in this way, but the question which we to-night are discussing is whether it is practicable for the State to advance money for this purpose, and, if so, how it might be done.

The Colonies, as I have already mentioned, give free land, and, for sake of example, I will deal with the question in the case of Canada, as I am best acquainted with that Colony; the principle, however, in the matter being applicable to nearly all the other Colonies.

The mother country gives nothing towards colonisation; now, it may be very fairly argued that it was equally the duty of the mother country to give an equivalent to the value of

land given by the Colony, as it is for the Colony to give the land.

In the case of Canada, the gift by the Colony of 160 acres of free land may be taken, at the present market value in the north-west of Canada, to be equal to £80, and, therefore, it is not an unreasonable contention that the Home Government should give £80 towards the development of the 160 acres of free grant.

As we have already seen, the advantage of such an interchange of population is equally great for the Colony and for the mother country. The answer, I am fully aware, to this proposal is, that the land, until it is developed, is useless to the Colony, whereas the money proposed to be given by the mother country would have to be taken from the pockets of the taxpayers, and is at the present moment useful to them in some other way.

But if we discard the idea of a free gift of money from the Home Government, let us look for one moment to see if an advance might be made by way of a loan. It has been reckoned, with tolerable accuracy, that the cost of conveying, of outfitting, and of settling a family of, say, five individuals, upon a free-grant farm in the north-west of Canada costs somewhere between £150 and £200. It is, of course, manifest that circumstances may very considerably alter the amount which is necessary to start a settler, circumstances connected both with the locality in which he may find himself, and also—and this is a more important consideration—the difference of ability and character of the settler himself.

We may, however, take it as not far from the truth that a sum of £170 is required for the average settler and his family, consisting, in all, of five individuals. The security for this sum would, after it had been fully expended, be represented by the prairie value of the land, the value of the improvements upon it, including the house, stables, ploughing and other operations, and would also include the farm stock and implements which must have been acquired, and for which allowance has been made in the £170. Now the probability is that the value of such property would be equal to the sum expended, but at the same time it would not be a sufficiently certain security for a prudent lender to advance the sum named upon, and therefore it is necessary to look around and see if some further security might be obtained.

The laws which prevail in Canada with regard to the distribution of Government lands are, that one-half of the land is set apart for free grant, and the other half is reserved for sale by the Government. Exception, however, must be made in this general statement with regard to certain amounts of land reserved for the Hudson Bay Company, and for education purposes.

These lands reserved for sale by Government are in most cases given either without any price, or at a very small or nominal figure, to the railway companies who undertake to make a railway through certain districts. In that way the Canadian Pacific and the Manitoba and North-Western Railway have acquired large tracts of the saleable portions of the land in belts on each side of their lines.

Now the proposition I wish to bring before you this evening, and which I think our Government might very well press upon the attention of the Canadian Government, and which I think the Canadian Government should agree to, is this—that any authorised or certificated company or corporation who undertook to settle certain portions of the free grant lands with settlers, advancing them money to do so, should be regarded in the same light as railway companies, and should be given a certain amount of the saleable lands contiguous to the free grant sections so settled, for any purpose which they might be able to make of them and without conditions of settlement.

This suggestion is not an unreasonable one, because colonisation companies would be really doing the work in even a more direct way for the benefit of the country than the railway companies could do, as, of course, the Colonial Government only gives this subsidy to the railway companies in the hope and expectation of getting settlers on their land, and, therefore, if the colonisation company is ready and willing to come forward with the capital and do the work, it should, in my opinion, be treated in the same way as the railway company is at present.

The effect of such an action would be that the security would be at once doubled, as far as the value of the land is concerned; and as I have already shown, the cost per acre of prairie land is about 10s. per acre, it would be apparent that the value of the land which such a company would get for each 160 acres settled would be £160—that is to say, 160 acres free grant land, and 160 acres of saleable land at 10s. per acre. Such an amount of land, added to the increased value of the land after the £170 advance had been expended upon it,

would be a sufficient and good security for the capital so advanced.

This, I think, might therefore be done with advantage to the Colonies themselves, in order to promote settlement, and, on the other hand our Home Government might, with equal advantage, advance money at a very low rate of interest, say 2½ per cent., to such certificated or authorised companies as I have suggested, and I have no hesitation in saying that, if a sufficient period of time were allowed for the development and realisation of the property so created, there would be no doubt whatever that the original advance could safely be made, and would be repaid with interest.

It will be seen that the prairie value of the land offered as security is very little less than the sum of £170 advanced, but I would appeal to the knowledge of everyone who has had anything to do with the development of new lands in confirmation of my statement that, independently of any outlay upon the land, by the natural process of settlement, the land acquires a greater value.

This has been the almost unvarying history of land in the United States, as well as in the old parts of Canada, and there is no reason whatever to believe it would not continue in the newer portions.

The foregoing is a brief outline of what I think is necessary to promote and stimulate the carrying out of the work of colonisation by borrowed capital; but in addition to these measures which I have already suggested, I think it would be very highly desirable that there should be a permanent Colonial Board appointed by our Government, such Board to consist, either as a sub-department of the Colonial-office, or, better still, as an independent Board with representatives of the Colonial and Imperial Governments upon it, as well as, perhaps, representatives of the subscribers to any Government loan for this purpose.

This Board, however constituted, and I have not time to-night to dwell upon its constitution, would be the medium for negotiating between the Governments of this country and of the Colonies, and would be charged with the functions of obtaining whatever facilities could be had from the Colonial Governments as to their land, and from the Home Government as to a loan of money, and it would also have to investigate the position and credentials of any society or company which applied to it as being desirous of undertaking this work.

It has been suggested by some that an Imperial Colonisation Board might themselves undertake the work of colonisation; but my own experience in this work, and also my own knowledge of human nature and of Government departments, leads me to suppose that this Board would be more effectively employed as an intermediary rather than as a direct agent for carrying on this work, work which it is needless for me to point out, requires the greatest care in the proper selection of settlers, and also the greatest personal attention to the settlers for some years probably after they have been settled upon their farms, and which it would be almost impossible for a Government department or for a Colonial Board properly to discharge.

I do not propose this evening to dwell upon the question of how these suggested loans should be raised or should be repaid, further than to say that I approve generally of the plan of the creation of a stock, which might be called a colonisation stock, which should be guaranteed by the Home Government, and that the loans made to the authorised companies should be repayable with interest in twenty years, and I would also merely remark that, as far as the settler was concerned, these repayments should commence after the second or third year, and be repaid in gradually increasing amounts until the whole was paid off. It is my belief, if a period of twenty years were given for repayment of capital and interest, there would be no difficulty or hardship in making such a stipulation.

I need not of course remind those whom I am addressing that the Canadian Government gives great facilities by law for the mortgage of free lands, so that no difficulties on that score would be found.

I would here venture to express my gratitude to the present Government, that they have seen fit to introduce a clause in the Local Government Bill which will give county authorities, under certain conditions, the power to advance money for colonisation purposes, and the Government has evidently had in their view the idea that such an advance might be made to companies or corporations who are able and willing to carry on the work.

It may be, therefore, that, for the present at least, we shall have to look to the views of the county authorities with regard to this matter, rather than to the Imperial Government, but, at the same time, if the county authority is willing in the first instance to give the guarantee to the Home Government for the payment of the interest to any loan, the chief

difficulty of inducing the Imperial Government to make such a loan would of course be removed, and in my opinion the usefulness and necessity of a colonisation board is not in any way removed by the proposals in the Local Government Bill.

I have now, I think, indicated—necessarily very briefly and in outline—how I think that the State could advantageously, and with safety, step in and assist emigration, and I hope that it will be generally admitted that, both as far as principle, and as expediency, and as practicability are concerned, I have proved a case for the intervention and recognition of the State in aiding and directing this method for the relief of the congested condition of our population.

I will only venture to remark, in conclusion, that emigration should not be looked upon as a thing to be done by fits and starts, and as a method of relieving peculiar and sudden destitution; but it should be regarded as a systematic and natural process, which will operate in a manner so that persons may be emigrated when they are fit and proper cases for emigration, and when they will make good emigrants, rather than when they are, by a process of destitution and semi-starvation, reduced to a condition when there is little or no hope of their being successful emigrants.

This question has, I rejoice to see, now reached the position of one of practical politics, and also is one which is, happily, not of a party character; and if by my words this evening I shall have been able to excite any further interest in this matter, and to have suggested any practical views upon the subject, or have advanced the question one step, I shall feel amply rewarded.

DISCUSSION.

Mr. J. Eastty said the importance of the subject could not be gainsaid, but to his mind there was a question at the back, viz.—What is it that makes emigration necessary? Adam Smith said the most decisive mark of the prosperity of any country was in the increase of its number of inhabitants, and, if it be true as a statement, the question arose—Why do you want emigration at all? The price of provisions at the present time was very low, the wholesale price of New Zealand butter being 6d. per lb., American cheese 6d. per lb., bacon 6d. per lb., sugar 1½d. to 2d. per lb., and tea 10¼d. per lb., so that there must be something radically wrong if the consumption exceeded the supply. The great point which rendered emigration necessary was the fact that children were not taught in early days to do anything definite. Those who had not learned a trade would do no good by emigrating. If, instead of sending children abroad, some scheme could be devised for training them, it would be a far more practical and economical question than any amount of State-aided emigration.

Mr. Crowther wished to know how the reader of the paper would provide for the large mass of the population that emigrated, having no trade, and not being agriculturists in any form or shape. The remarks which had been made specially applied to those who went out with the intention of taking up land; but a very large proportion who went to Canada had no trade or knowledge of land cultivation, in fact, they were what might be described as the flotsam and jetsam of the population. A man desiring to emigrate generally considered where he could go for the least amount of money, and the result was that the Colonies were flooded with people whom we were glad to get rid of, but these people did not contribute to the advancement of the Colony. There was another aspect of the case. The small capitalists of £150 or £200 were those who made the best colonists, but often a man hesitated to go on account of the expense, and if these emigrants could, on arriving, be assisted by the Government, it would be a material help to them, and, at the same time, to the Colony. These were the men who would be willing to recoup the Colony for the money advanced.

Dean Grisdale said he had lived in Manitoba for the last fifteen years, and was specially pleased to see that the proper selection of the emigrant was one of the strong points which Mr. Rankin made. With regard to child emigration in particular, in the Colonies they were exceedingly jealous, not only of the training of the children but of the parentage. Last year an influential deputation came from one of the English societies to see whether a branch could be formed in Manitoba, and the inquiry at once made was — from what source are the emigrants coming? The criminal classes were not desired in the Colonies, they wanted men of good moral character, ancestry, and physique. They did not welcome remittance men, that is to say, young men who had been guilty of some indiscretion at home, for these became rather a nuisance in Manitoba. What they wanted were hard working sturdy men, who meant to settle on the soil and bring out its well-known capabilities. He could quote hundreds of cases where men who had paid for their land became, after a few years' hard work, prosperous. If the mother country would send out good strong, sturdy, moral men and women, he could assure them that prosperity was before them. He desired to thank the reader of the paper for the thoughtfulness shown in the treatment of the various points.

The Chairman said Mr. Rankin had very truly stated that emigration pure and simple, aided by the

State, would not be encouraged by the Colonies. By that he meant assistance to persons to emigrate who were not wanted in the Colonies, and for whom there was no demand. In the Colonies, the supply and demand for labour, excepting, perhaps, for farm-labourers and domestic servants, had been more or less equalised by the large expenditure to which reference had been made. Everyone would admit that if the Colonies were to encourage a large influx of immigration of a character which was not wanted—of the classes of labour for which there was no demand—they would practically be reproducing, very unwisely, the unfortunate state of things existing in this country, and which had given the question of emigration such a degree of importance during the last few years. Apart from the question of assisting emigration of this kind by the State, they found that the population of the Colonies had reached such an extent that the immigration which took place voluntarily of mechanics and labourers was quite sufficient for the time to meet the requirements of the labour market. He entirely agreed with Mr. Rankin's opinion that colonisation was the only method by which the Colonies could absorb a large number of immigrants in addition to the ordinary immigration, though he might differ with him upon some details of the scheme. He thought Mr. Rankin had been caught napping during the last few days, or he would have mentioned the fact that the Government had accepted the vital principle for which he had been working, and were going to ask Parliament to vote some thousands of pounds for the purpose of assisting a number of Scotch crofters to emigrate to North-West Canada under a colonisation scheme, which had received the general approval of the Canadian Government.

Mr. RANKIN said he had briefly alluded to this fact in his paper.

The CHAIRMAN said he had not noticed that it was given the prominence which it deserved. At any rate it was an important recognition of the principle of colonisation, and was a step which would repay further development later on. Colonisation upon such a plan as had been mentioned could, he thought, be carried out with success in Canada, where there was plenty of unoccupied fertile land, and in England there were plenty of people who would gladly avail themselves of it. He thought there could be no higher aim of statesmanship than to bring the unoccupied people and the unoccupied land together, as it would be to the advantage of the whole Empire. The great difficulty was the question of money. The question whether it was possible for such a scheme to be carried out on a commercial basis had, however, rather got beyond the region of experiment. The whole of the development of the Colonies was really a record of successful colonisation; and upon the principle of advancing money to settlers to make a start in Canada, they had recently had the case of Lady Gordon Cathcart, and the East-end Colonisation Fund. These settlements had the elements of success in them, and those connected with them had no doubt whatever that, at the proper time, the people who had been assisted would return, not only the principal, but the interest on the money advanced to them. He agreed with Mr. Eastty that, while they spoke of emigration as a remedy for a number of the evils which the working classes laboured under in this country, they should try to find out what was at the bottom of the difficulty which caused the necessity for migration on a large scale. He could not agree with some of the other remarks, that they had everything in this country they could possibly desire. Food might be cheap, but if people had not money to buy it with, cheapness was of no advantage to them. With regard to the effects of colonisation, he thought, if they took a nnmber of people away who were suitable for the Colonies, they would create a better demand for the labour of those who were left behind. The great difficulty was that there was not enough work for every one. If a scheme of colonisation were carried out on the lines mentioned by Mr. Rankin, it would cause what might be described as a "levelling up." Increased emigration to the Colonies would mean increased trade with the mother country, and would increase the demand in the labour market. He agreed with the remarks of Dean Grisdale as to the classes of people wanted in the Colonies. If any scheme of colonisation was arranged, he hoped no one would be sent out unless they had in some way or other received the prior approval of the representatives of the Colonies in this country. In conclusion he begged to propose a cordial vote of thanks to Mr. Rankin for his instructive address.

Mr. RANKIN said that one of the chief functions of the Colonisation Board which he thought should be established would be to see, through its agents, that a proper selection of emigrants was made. If, instead of letting people get down to the condition of paupers, and then paying a large sum to relieve them, a system of State-aided colonisation was set on foot, it would be much better, as they would then have happy and contented people on the other side of the ocean, instead of as now—a large amount of population who were neither contented or happy. Mr. Eastty had alluded to what he called the bottom of the difficulty, but the bottom of the difficulty was the incapability of sufficient production, owing to the limited area of this conntry. England being a country of limited extent, had pretty well reached the limits of capability of production, and, therefore, they must look round for some other source of supply. No doubt it would be greatly for the benefit of this country if they had a little more technical education; not that he was of opinion that you could make accomplished artisans by any amount of technical

education, but boys and girls might, by being taught some trade, be made more handy and useful than they were at present. He could not endorse the statement that England sent the lowest of the working classes to the Colonies, for he had frequently heard it stated that she sent the best, and, therefore, he should be inclined to take a middle view in this matter. He was glad that Dean Grisdale did not discountenance the idea of child emigration, and hoped that when that gentleman returned to Manitoba he would try and overcome the prejudices that existed with regard to ancestors. He considered that if children were taken early enough, and properly trained, they would make good men and women in their station of life, and be a credit to the Colonies. Of course if it were found that the criminal classes were being sent abroad a stop should be at once put to this, but he had drawn a very broad line in his paper between those who had and had not committed crime, and he should always continue to draw this line. He did not wish to put a a stop to the emigration of children from reformatories, but he would not ask the State to grant money to assist this kind of emigration, knowing the feeling that existed about it in the Colonies. As to selection, he believed the essence of any scheme was that the emigrants should be carefully selected, and it was not the wish of those promoting this work to send the scum of London to the Colonies. He might say that the Government had now moved in the matter by appointing a Colonisation Board, upon which there would be colonial representation. The scheme was entangled by some clauses with regard to the voluntary contribution connected with the advances, which were unwise, but all the money proposed to be spent upon this scheme was £10,000, which was a mere drop in the bucket. Perhaps it was the beginning of a larger and more extensive scheme, and he looked upon it as important, because it acknowledged the principle of the scheme. He wished particularly to direct the Chairman's attention to the proposal which he had made in his paper, and which he regarded as the most important point in the whole of the question, namely, that the Canadian Government should give increased facilities with regard to the land, and he suggested that they should either give the pre-emption right to 160 acres adjoining a free-grant farm, or a block of land of sufficient size, which should be half for settlement, and half for sale. If this was done, the prairie value of the land would be equal, or very nearly equal, to the advance made to the settler, and, with the improvements upon the land, would make the security absolutely good. He wished to direct the attention of the Chairman to this point, because the companies which he suggested might carry out the work of colonisation would be actually doing the work in a more direct way than the railway companies, which had had similar concessions of land made to them by the Colonial Government.

A MEMBER called attention to a telegram that appeared in that evening's newspaper, complaining of the arrival in Toronto of large numbers of pauper immigrants.

The CHAIRMAN said he had no official telegram upon the subject, but he thought the statement was much exaggerated. The Canadian Government gave assisted passages to certain classes of emigrants, but this was withdrawn a few weeks ago. Of course, before the withdrawal took effect, there was a great rush to get the benefit of the assisted passage, and the arrival of unusually large numbers of people within a few days may have caused a temporary difficulty in disposing of the immigrants. If the people who went out were of the classes recommended, he was sure, however, that there would be no difficulty in absorbing them. With regard to the Crofter and East London settlement, he believed no payment had been made as yet, but the statistics showed that the settlers who, after paying their passages, had about £80 to £100 to invest in their farms, now owned stock and implements valued at two or three times those amounts, irrespective of the value of the land, which was now worth double or treble what it was when they first occupied it.

The vote of thanks having been carried unanimously, the meeting adjourned.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 16, 1888; Colonel A. C. HAMILTON, R.E., Member of Council, in the chair.

The following candidate was proposed for election as a member of the Society:—

Phillips, George C., The Limes, Grove-road, Chelmsford.

The following candidate was balloted for and duly elected a member of the Society:—

Humphrys, Norton Henry, Gas Works, Salisbury.

The paper read was—

ELECTRIC LIGHTING FROM CENTRAL STATIONS.

BY R. E. B. CROMPTON.

The object of this paper is to put before you, the Society of Arts, some data from which you can form your own opinions on the vexed question whether the electric light will soon be generally distributed as a means of lighting our houses. Although we see electric lighting

extending on all sides in large establishments, many of you think that for some time to come it is likely to remain a luxury reserved for the rich. I hope, however, to show you that this need not necessarily be so, and that one very potent means of furthering its wider introduction is by making generally known the causes which are now retarding it. As all of you know, our private houses can only be lighted on an extended scale from central stations, and I wish to call your attention to the various points in which this central station lighting differs from the detached installations, which are now so well understood that they no longer present features of special interest. The plant for producing the electric light may be divided into generating and distributing apparatus. In a detached installation the whole system of engines and dynamos generating the electricity, with the conductors distributing it to the lamps, is self-contained, generally within one building. At any rate, the system of conductors which connect the generating station with the lamps does not extend beyond the property of the consumer; but in the case of central station lighting, the electricity is generated at a station placed more or less centrally to the area to be supplied, and from thence the conductors are taken through the streets to be lighted. It is the difficulty of dealing with a system of conducting mains passing through the public streets which has so long retarded the investment of capital in systems of supply from central stations.

Lord Crawford and Mr. Ferranti, and others working with them, have within the last two years distributed electricity by means of overhead wires, from a central station close to the Grosvenor Gallery. They have been able to do this because at the present moment no one has any control over the fixing of overhead wires. It is only necessary to obtain the consents of the householders of the roofs upon which it is proposed to place the supporting posts. Such a system of distribution has answered extremely well so long as central stations have had to pick their customers far and wide, but the case will be very different when all the houses, or the greater part of them, take the light. When this is the case, it will be absolutely necessary to put the conductors underground. I myself am engineer to a company which is successfully working a central station at Kensington, for supply to the houses around Kensington-gore and Knightsbridge, and in this case I have commenced by putting all my conductors underground, and have experienced not a few of the difficulties which I am about to describe.

As I believe after all that the cost of electric lighting will be the chief factor in determining its future extension, I think it best to commence by showing you that the main body of householders can only afford to spend a certain sum on their lighting, so that, if the electric light cannot be supplied for this sum, its use will be restricted. The usual laws of demand and supply will hold good when applied to the sale of electricity as to any other commodity; that is to say, for equal profits the price can be reduced as the extent of the sale augments. But we must start with a sum which a householder can now afford to pay, and I think I can show you that, light for light, this sum may be considerably higher than that now paid for gas. Let us see what this amounts to. A Londoner who is tenant or owner of a house having three reception rooms, ten bedrooms, and the usual offices and passages—in all, having about fifty burners fixed in them, spends about £25 a year for his lighting. His gas bill will be about £15; lamp oil, candles, and matches, about £10. His average coal bill will be about £25. But this £50 does not nearly represent the total cost of his lighting and heating. Repairs, renewals, cleaning of the house and furniture inseparably connected with the lighting and heating, form a large item—in fact, a larger item than anybody would imagine who had not added them up and averaged them over a term of years. Although a great deal has been made of the damage done to ceilings, hangings, the bindings of books—in fact, everything fixed in the upper part of our rooms, by the fumes and smoke of burning gas, few people consider what a large share of the labour of our household servants is connected with cleaning grates, carrying coals, and the dusting of furniture, caused by the use of coal; how greatly the wear and tear of our carpets is increased by droppings from candles, by hot cinders falling from the grates, and by perpetual lifting to make way for the chimney sweep, and by carrying coals up and down stairs.

A large proportion of the small repair bills we pay are in connection with the kitchen and other grates, hot-water boilers, gas fittings, candlesticks, lamps, oil, and the like. In fact, it is not too much to say that if we deduct the one important item of the repair of the exterior and the roof of the house itself, four-

fifths of the remainder of our annual repair and cleaning bills are spent in connection with lighting and heating. And it is quite certain that if electric light was introduced into such houses, and the bulk of heating and cooking done by gas, then this heavy annual bill would be considerably reduced, probably by £30 or £40 at least. Our householder could then well afford to pay £25 for his electric light, £20 for the increased quantity of gas he would use for heating, and, as English people will always insist upon an open grate in the drawing-room, £5 for wood fuel for this drawing-room fire. His pocket would then be the gainer of the £30 or £40 that he would save on repairs. We thus see our way for an income for the electric light company, providing that they can light a house for £25 a year, and this without ousting the gas company. The seller of house coals would no doubt suffer to some extent, but he would be partially compensated by selling steam coal to the electric light companies. Although this picture of the lion lying down with the lamb (*i.e.*, the gas company with the electric light company), seems almost too utopian to be realised, I think it deserves your most careful study and attention, for in its partial realisation we may have some hope of fighting the smoke and fog demon which overshadows our beloved London. And I assure you that if you, the householders, will play your part, by encouraging the use of gas cooking and heating, and by taking up electricity for lighting, we, the electric light people, will play ours and will supply the electricity.

I have above mentioned the sum of £25 a year as one that could be paid by a householder owning or tenant of a house of the size I have taken as representing the average, having 50 electric lights fixed. At present it has been found that supply companies cannot charge much less than 8d. per Board of Trade unit for electricity. Now £25 a year means a trifle over 2 units a day at this price, and this is equal to only 31 lamp-hours if the large 20 candle-power lamps are used throughout; but experience has shown us at Kensington that the nicest lamp to use is one of about 10 to 11 candles, taking 33 watts. The 2 units per day will be sufficient for 62 such lamp-hours, and practice has shown that this average daily supply is amply sufficient for the brilliant lighting of such a house as I have described, if due care has been taken in the placing of the lights, and arrangements are made to switch off the lights in the rooms and passages in which light is not constantly required. As with gas, so with electricity; the burners that make up the bill are those that are constantly burning, such as lamps in the hall, in the various passages, on staircases, &c. But there is no need for those who wish to be economical to burn electric lamps constantly in places corresponding to those it is necessary to keep gas constantly burning. The reasons being obvious, it is not worth while to frequently turn out the gas and then be at the trouble of getting matches and relighting it each time a person goes backward and forward, whereas the handling of an electric-light switch is quite another matter. I have recently devised means by which the whole series of lights from the entrance right up to the passages at the top of a house can be turned on simultaneously from any part, either from the entrance or from the first floor, or from the top of the house, so that anyone coming home late and finding his home in darkness can light up the whole of the passages by one switch as he enters, and put the whole out again as he goes into his bedroom. By such devices as these, great saving can be effected in the quantity of electricity used, as the saving made in the current used by these constantly burning lamps allows for a corresponding increase of lighting in the dwelling and bedrooms at other times. It is manifestly against the interests of the electric light that it should always be associated with an extravagant display of light. Where much light is given, it must necessarily be expensive, and people are consequently deterred from adopting electricity. The best customers a lighting company can have are those who use their lights to the best possible advantage. It is far better for a lighting company to have to supply current to a large number of economical customers than to a smaller number of less thrifty ones. Another method by which the cost of the electric light may be greatly reduced to the householder is by the increased use of portable fittings, such as table standard lamps, removable brackets, and such like. Setting on one side the not inconsiderable saving to the householder of the cost of the fittings themselves, the mere fact that such fittings are used considerably reduces the maximum number that can be intentionally or accidentally turned on at one time, and thus greatly reduces the size of the generating plant required to supply this

maximum. Further than this, the smaller unit of light placed in a table standard close to the writing-table is, of course, more efficient than lamps hung from the ceiling.

Having shown you that you can have your electricity, and can afford to pay for it, I want you to understand the difficulties which beset the electrical engineer, who has to provide the system of distributing mains from the generating station to your houses. As I have before said, in this portion of the undertaking lies the whole of our difficulties. The regulation of these mains has been made the subject of an Act of Parliament, which has undoubtedly been one cause of retarding electric lighting in this country; at any rate, it is difficult for anyone who has not himself been engaged in this work to realise the long and wearisome delays, and the obstructions thrown in the way of electric light companies striving to obtain the requisite permission to lay these conductors.

As I have above shown, we do not wish to be rivals of the gas companies; we wish to live alongside of them. We believe there is room for both of us; but still comparisons will be made, and it is only fair to say that the conditions under which we at present labour are not equally fair to gas and to electricity. The gas companies have certain well defined powers and well defined obligations. There has been no attempt to apply to them the doctrine that all undertakings for public supply must have but a limited tenure only, and become the property of the public authority after certain fixed periods. It has been said over and over again that never more will such powers be given in perpetuity as are now given to the gas companies, but still every year Parliamentary sanction is given to new undertakings under the Gas Acts, which grant these very self-same perpetual powers. No one appears to have brought forward the absolute unfairness of this course; but as long as this difference exists, it is manifestly a logical sequence that as capital which will be employed by electric light companies will not have the same security of tenure as that employed by gas companies, the former will have to pay dearer for it. This feeling that the electric light companies are to pay ransom in some form or other has got so strongly into the minds of the various local authorities, whose permission must be first obtained before conductors can be laid in the streets, that it is at the present moment a very potent cause of delaying the introduction of the light. I have never been able to understand why clear-headed men of business sitting on our London vestries, when they set themselves to consider the applications of the electric light companies to lay conductors, appear to forget the most obvious principles which govern supply and demand. No doubt their dislike to the present commanding position obtained by the gas companies is the reason for their caution. They appear to think that unless they tie the electric light companies hand and foot, the gas monopoly will be repeated, forgetting that although the gas companies at present have the monopoly of lighting, the mere fact of the wide introduction of electricity would destroy this monopoly, and by introducing competition accomplish the very thing that they desire. Still more incomprehensible is the wish of some of these bodies to become themselves the suppliers of the electric light. Surely the enterprise is not in such an advanced state that sufficient data have been accumulated to show that public moneys may be safely invested in systems of electric supply. How can any member of a vestry or local board imagine that his board would be allowed to raise money on the security of the rates for the purpose of supplying electricity to only a part of the ratepayers; but such, nevertheless, is the case. Many members do think so, and the operations of the electric light supply companies who are seeking permission to lay their mains are delayed accordingly. There is no need for local authorities to be thus chary in granting permissions to respectable companies, for they have ample means of protecting the interests of their ratepayers from a dear and inefficient supply of electricity. They are not able, even if they wish it, to grant any monopoly to any one lighting company to lay down their conductors in the streets, so that, in the event of the first company abusing the powers given to it, either by charging too high prices or by not supplying a regular and constant service, they can correct the matter by allowing a second company to compete. An efficient service of electrical supply is very easy to define. As long as the E.M.F. or electrical pressure is kept constant, and there is no break of continuity in the supply, nothing further need be asked for, as electricity, not being a material substance, cannot be adulterated; or, as Sir Frederick Bramwell once put it very happily, there is no need to define how many grains of sulphur are allowable in an ampère of electricity. In addition to the long and wearing delay of obtaining the con-

sent of some of our local authorities (and it must be remembered that London is so split up that it is very difficult to obtain a district which does not trench on ground of more than one vestry, so that the final consent of several vestries must be obtained before the work can be proceeded with in any portion of the district intended to be lighted) there are several other delays in the shape of permissions to be obtained from the Board of Trade and from the Postmaster-General. On the whole, it may be said that, as the law now stands, it takes nearly a year to obtain all the permissions that are necessary before the contractor who is to lay the conductors can break ground; and it is obvious that if you, the English public, really are anxious for the light and intend to have it, you have it in your power to direct your vestrymen to be less obstructive. After all permissions have been obtained, an entirely new series of troubles is met with. Anyone of you who have seen a trench open in a London footway must have noticed the large number of small service pipes which cross the footway at right angles. These pipes are at all depths; some of them close to the surface of the ground, some of them very much deeper. In most cases the footways pass over cellar arches. It will be seen that there is very little space between the crowns of these arches and the under-side of the flags or the surface of the asphalte. But this small space is all that is available in which to lay the electric conductors, and our troubles in arranging to get them into it are not small. I should much like to use the French word "canalisation" for the whole system of conductors which convey the electricity from the central station right up to the lamps. We have no equivalent English term; the nearest expression that I can use is to call the "canalisation" the conducting mains. These conducting mains, the material they should be made of, and the best method of laying them, form the most difficult point that the electrical engineer has now to deal with. It is the one part of the plant which is hardly at all employed on private installations, even if these are of large size; consequently we English engineers have had small experience to enable us to determine the best material to use and the best methods of laying. In America, where the progress of central stations has been so very great, in most cases overhead wires have been used, fixed to posts in the street, but this I do not think would be allowed at all in England, and certainly not in London. Nor is any great extension of the present system of overhead wires, such as you use radiating from the Grosvenor Gallery, likely to be allowed. We, therefore, have to devote all our energies to the best, cheapest, and most durable methods of laying our conductors underground, and as far as possible in the footways.

The various modes of laying the conductors may be divided into two classes. 1 By insulated cables, with the appearance of which you are all familiar, laid either in troughs, drawn into pipes, or into bitumen cases, or (2) by bare copper conductors stretched on earthenware or glass insulators in culverts or small subways, formed just beneath the surface of the footway. One or other of the first methods is most commonly employed. But during the last year I have laid down at Kensington considerable lengths of bare copper conductor in culverts as above described, with most satisfactory results. The completed conductor consists of such durable materials, and the facilities for repairs and renewals, and for exchanging or increasing the size of the conductor itself, are so great, that it is particularly suited for electric lighting at its present stage, when we are very uncertain as to the number of houses that each conductor will have to supply during the next few years. Our case is very different from that of the gas companies, who lay down their mains with the full knowledge that every house fronted by the mains will have to take the gas to a larger or smaller extent. We, on the contrary, having to compete with the existing supply, in most cases do not know what proportion of the houses will take the current. It is a great point, therefore, to be able to lay down a small conductor in the first instance, and to increase it by adding copper at a later date; in fact, any system we employ must fulfil this requirement. If it were not for the many transverse pipes above-mentioned, the culvert system I have described would best fulfil all the requirements, but unless these pipes can be all got below the culvert, or grouped so as to cross the culvert at regular intervals in masses of solid brick-work, it would not be safe to use the bare copper conductors, for when these stretch they might come in contact with the pipes, and so make an earth connection. For such places we have to effect a compromise, by using short lengths of insulated cable drawn into pipes or bitumen cases. However, we must always so arrange matters that we can

alter, repair, or renew the cables without again breaking up the surface of the footway, and this we must do by having surface boxes with removable covers, at frequent intervals, through which access can be given to the culverts, or to the pipes containing the conductors.

The probability that for some years to come we shall not supply the current to a considerable per-centage of the houses fronted by the mains, makes it at present necessary to estimate for a great length of conducting mains in proportion to the houses supplied. After careful consideration, I have come to the conclusion that in London we cannot calculate on requiring less than twenty yards of main conductor laid for every house supplied; that is to say, for 1,000 houses we should require 20,000 yards of conductors; and as the cost of taking up and replacing the surface of an asphalte footway is about 11s. a yard, you will see that this item alone comes to more than £5 of capital charge for every house supplied. A great point would be gained if it were rendered obligatory on the gas and water companies to place their service pipes at a greater depth below the surface than they are at present, and this could be very easily arranged. If this could be done in all cases, so that culverts measuring eight or nine inches in the clear could be provided, it would make the laying and care of our conductors comparatively plain sailing, and would save enormous sums of money to the lighting company, and hence would re-act favourably on the cost of the light itself.

About half of the capital required for a central station supply system is required for the conductors themselves; so that I do not think that I have dwelt at too great length on this portion of the subject. Hitherto it has been the weak spot in all estimates, both for capital and maintenance, that we have been able to lay before intending investors; but the uncertainties, both as to first cost and cost of maintenance, are rapidly being removed, on account of the data we are obtaining from works recently carried out.

We may now discuss the question of electric light supply companies as an investment for capital. I think no one will deny that enough has been done to show that electric light can be produced at a certain cost in detached installations, and I have shown above that the only unknown factor which introduces an element of uncertainty in the cost of production by central stations is the one of first cost and maintenance of conductors. But even if we charge the cost of production with the highest figures for cost of maintenance of conductors that are reasonably possible, we have ample grounds for showing that capital invested in electric supply will be highly remunerative so soon as the demand for lighting becomes general. Adopting the figures before given, viz., 8d. per unit, and estimating that the income from each house taking the light will average about £25 a year, I have made calculations that the company will cover its expenses and begin to pay dividends as soon as the number of houses taking the light exceeds 20 per cent. of the whole number fronting the mains. Roughly speaking, the capital required for plant of every description may be taken at £50 to £60 each house supplied. I think it is likely that there will soon be a revulsion of feeling in favour of this class of investment. No doubt for some years we have been feeling the over-speculation in electric light shares which took place in 1881 and the years immediately following, when companies were promoted for the sole purpose of selling electric patents. The case now is widely different. As I have just said, the bulk of the money required will or ought to be spent in providing plant, of which half will be the cost of the conducting mains. I use the word *ought* because at present the Parliamentary and other costs connected with obtaining permissions, to which I have called your attention, are very heavy, and I cannot help thinking that the greater part of them is unnecessary. One of the great enemies to the progress of central station lighting has been the wild promises that have been made by inventors of various forms of primary batteries, who are telling you every day that they will light your houses with some form of primary battery that can be put in your cellar, and will require no attention. I have been over and over again told by my friends that they intend to have nothing to do with the electric light until they can get it in some simple form of this kind, and that they feel convinced that they will get it. The sooner the conviction is brought home to them that anything of the kind is absolutely hopeless, and that the large amount of electrical energy required for lighting your houses cannot by any possibility whatever be generated in the space available in a cellar, the better it will be for electric light prospects. I make this assertion confidently, as I know I have the whole body of electrical engineers at my

back. I do not call inventors of primary batteries, or promoters of companies connected with them, electrical engineers in any sense of the word. They are in most cases self-deceivers who believe in their own promises, but they do not understand the most rudimentary laws of the conservation of energy or of the value of commercial products. One favourite bait they offer to an intending investor or intending user is, that he will be able to sell the waste products of his battery at a higher price than he gave for the materials originally put into it. They do not seem to see that the obvious question that everybody must at once put to them is—Why do not, then, chemical manufacturers at once adopt these batteries as the means of manufacturing this self-same product? But it is useless wasting words on this subject. I only wish to point out to you that every man who puts off the lighting of his house in the hope that some day some wonderful invention or improvement will be produced in the form of a primary battery is an enemy to the progress of the electric light. The capital for electric lighting must always to a large extent be invested in generating machinery and in distribution by means of conductors. In these conductors little or no progress is likely to be made further than in the direction I have indicated of an improved system of culverts to contain them. We know the generating machinery has already reached a high degree of perfection. Every day we hear of sets of steam-engines and dynamos returning in the shape of electricity from 75 to 82 per cent. of the energy put into the cylinder of the steam-engine. Having already obtained such high efficiencies, we can hope for very small advantages to the consumer from further improvements in either generating or distributing plant. Doubtless great improvements will be made in the manufacture of the incandescent lamps we use. They may be made vastly more efficient, but every man using the electric light will be able to avail himself continuously of the improvements of the lamps by putting them in as his old ones wear out; so there is no reason why he should put off taking the light on this account. I have shown you that it will pay the householder handsomely to take the electric light now at the comparatively high price we must charge so long as only a small per-centage of the houses take the light. Prices can be reduced and profits augmented simultaneously. The consumer will get the benefit of reduced prices, and the investor simultaneously will get better profits as every man persuades his neighbour to take the light. We are told that the cost of wiring houses, and the fact that we have not yet got a trustworthy meter, are two formidable objects to the spread of electricity. It is quite true that no man likes to be called upon to spend £100 in putting in the wires and electric fittings in a house in which he has already spent a considerable sum on gas-fitting. The electric companies would no doubt be willing to furnish the wires and fittings on the deferred payment system, but, unfortunately, in the present state of the law, they would be unable to retain any property in the wire and fittings during the time that the instalments remain unpaid. So that, in default of payment, they would not be able to take them back again, as the wiring and greater part of the fittings would remain fixtures, and the property of the landord. It is possible that a clause might be introduced in the Electric Lighting Bill now before Parliament, putting electric light fittings into a different category to ordinary landlords' fixtures. At present, no householder who is near the end of a lease is likely to to take up the electric light, and this matter obviously requires remedy.

So far I have kept this paper as little technical as possible, and have said nothing about the best system of distribution to be employed, or on the vexed question of transformers *versus* accumulators. I myself have recently read a paper at the Society of Telegraph Engineers on this subject, and placed before that Society the results of my investigations on the capital and maintenance cost of lighting a district of London by the two methods of alternating currents using transformers, and direct currents using accumulators. The general results arrived at, however, are before you in the tables which you see on the wall. Table 3 (p. 741) shows that the cost of generating and distributing plant, carried out on either of the above systems, will cost about £60,000 for plant sufficient for 1,000 houses of the size I have throughout spoken of. Table 4 shows that the working expenses of producing the electricity for these 1,000 houses would vary from £8,600 to £12,000, according to the system adopted, the gross income in both cases being £25,000. This paper has been hotly discussed, but entirely from the point of view that all my prices both for capital charges and for maintenance were fixed too high. Without taking advantage of this opinion, the above figures give at length the data on which

TABLE No. I.—Cost of Laying 100 Yards of Double Conductor Underneath the Footway of a London Street.

—	Single No. 16.	7/16	19/15	19/12	19/10	37/10	Two Sets. 37/10	Four Sets. 37/10	Six Sets. 37/10
Area, square inch	·0032	·0225	·0773	·1613	0.25	0·5	1·0	2·0	3·0
Area, square millimetre	2·08	14·6	50	104	161·25	322	645	1,290	1,935
Weight per 100 yards run. lb.	7½	53½	183¼	392	576	1,153	2,306½	4,612	6,918
	£ s. d.	£ s. d	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Cost of copper at 7¾d.	0 4 10	1 14 6	5 18 0	12 13 0	18 15 0	37 5 0	74 10 0	149 0 0	224 0 0
Cost of insulation	1 3 2	4 8 6	11 2 0	24 17 0	35 17 0	70 15 0	141 10 0	283 0 0	424 0 0
Total cost of cables	1 8 0	6 3 0	17 0 0	37 10 0	54 12 0	108 0 0	216 0 0	432 0 0	648 0 0
Casing, bitumen, & cement	5 3 0	5 5 0	8 0 0	12 10 0	12 10 0	16 0 0	22 0 0	40 0 0	55 0 0
Labour, laying	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	18 0 0	35 0 0	50 0 0
Trenching and repairing	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	30 0 0	35 0 0
Surface boxes & connection	5 0 0	7 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Engineer & superintendent	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	10 0 0	20 0 0	25 0 0
Total	42 11 0	51 8 0	70 0 0	95 0 0	114 2 0	179 0 0	301 0 0	567 0 0	23 0 0
Add extra, if copper at 9½d.	0 1 1	0 8 0	1 7 0	2 17 0	3 5 0	8 10 0	17 0 0	34 0 0	51 0 0
	42 12 1	51 16 0	71 7 0	97 17 0	117 7 0	187 10 0	318 0 0	601 0 0	874 0 0
Cost of copper per lb, laid complete	5 13 6	0 19 4	0 7 9	0 5 0	0 4 1	0 3 3½	0 2 8¾	0 2 7¼	0 2 6¼
Current in ampères	1·2	8·1	28	58	90	180	360	720	1,080
Cost per ampère	35 10 0	6 8 0	2 10 6	1 13 9	1 6 0	1 1 0	0 17 6	0 16 8	0 16 1

TABLE No. II.—Cost of Laying 100 yards of Double Conductor of Bare Copper carried on Insulators in a Culvert.

Area in square inches	0·25	0·5	1·0	2 0	2·55	3·00
Area in square millimetres	161·25	322·5	645	1,290	1,645	1,935
Weight of copper in lbs. per 100 yards	576	1,153	2,306	4,612	6,125	6,918
	£ s. d.	£ s. d.	£ s d.	£ s. d.	£ s. d.	£ s. d.
Cost of copper at 7¾d. per lb.	18 15 0	37 5 0	74 10 0	149 0 0	190 0 0	224 0 0
Laying	9 0 0	9 12 0	9 12 0	9 15 0	9 15 0	10 0 0
Insulators	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6
Six surface boxes and connections	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Culvert, 18 in. × 12 in., for two lines conductor, in brickwork and cement, replacing pavement	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0
Engineers and superintendence	6 0 0	10 0 0	10 0 0	10 0 0	10 0 0	15 0 0
Total	97 7 6	120 9 6	157 14 0	232 7 6	263 7 6	312 12 6
Extra for copper at 9½d. per lb.	3 5 0	8 10 0	17 0 0	34 0 0	43 10 0	51 0 0
Total	100 12 6	128 19 6	174 14 6	266 7 6	306 7 6	363 12 6
Cost of copper per lb. laid complete	42d.	27d.	18·2d.	13·8d.	12d.	12·6d.
Current in ampères	90	180	360	720	910	1,080
Cost per ampère	1 2 3	0 14 5	0 9 8	0 7 5	0 6 9	0 6 8½

TABLE III.—Cost of 10,000-Light or 600-Kilowatt Plant.

A.T.—Alternating Transformer Distribution.

	£
Generating Station, Buildings, Chimney Shaft, Water Tanks, and General Fittings	11,000
Dynamos and Exciters—865 Kilowatts, including spare sets, divided as convenient	5,540
Motive Power, *i.e.*, Engines, Boilers, Steam and Feed Connections, Belts, &c., at £8 12s. per I.H.-P.	12,470
500 Transformers, *i.e.*, one to every pair of houses, at £15 each	7,500
2,000 yards Primary or Charging Main, exterior to area of supply, at £308 per 100 yards	6,160
20,000 yards Distributing Main, 50 mm. sectional area, at £91 7s. (*see* Table I.)	14,270
Regulating Gear	500
	£57,440

B.T.—Accumulator Transformer Distribution.

	£
Generating Station, Buildings, Chimney Stack, Water Tanks, and General Fittings	[illegible]
Dynamos—600 Kilowatts, in 6 sets of 100 Kilowatts each	4,800
Motive Power, *i.e.*, Engines, Boilers, Steam and Feed Connections, &c., at £8 12s. per I H.-P.	8,600
4 Groups of Accumulators, in all 240 cells, in series, at £40 per cell, including Stands	[illegible]
2,000 yards Charging Main, at £306 17s. 6d. per 100 yards (*see* Table II.)	6,137
20,000 yards Distributing Main, 161·25 mm. sectional area, at £100 12s. 6d. (*see* Table II.)	20,125
Regulating Gear	2,500
	£59,762

TABLE No. IV.—Working Expenses and Maintenance of 10,000-Light, or 600-Kilowatt, Plant.

——	A.T.		B.T.	
	£ s. d.		£ s. d.	£ s. d.
Materials—				
Coal: 4,380 tons at 17s.	3,723 0 0			
,, 2,550 ,, 17s.	...		2,167 0 0	
Oil, water, and petty stores: 1,500 hours at 7s. 6d. + 7,520 hours at 1s.	925 0 0		...	
Oil, water, and petty stores: 1,400 hours at 5s.	...		350 0 0	
Total cost of material		4,648 0 0		2,517 0 0
Labour—				
2 foremen drivers at 45s., 6 drivers at 30s., 9 firemen at 24s.; sundry labour	1,388 8 0		...	
1 foreman driver at 45s., 2 drivers at 30s., 3 firemen at 24s; sundry labour	...		975 0 0	
Salaries—				
1 chief at £500, 2 assistants at £200 each, 4 clerks at £80 each	1,220 0 0		...	
1 chief at £500, 1 assistant at £200, 4 clerks at £80 each	...		1,020 0 0	
		2,608 8 0		1,995 0 0
Maintenance of Plant—				
Motive-power and dynamos: 10 per cent. on £18,010	1,801 0 0		...	
,, ,, 10 per cent. on £13,400	...		1,340 0 0	
Buildings and fittings: 5 per cent. on £11,000	550 0 0		...	
,, ,, 5 per cent. on £8,000	...		400 0 0	
Transformers: 10 per cent. on £7,500	750 0 0		...	
Accumulators: 15 per cent. on £9,600	...		1,440 0 0	
Mains: $7\frac{1}{2}$ per cent. on £20,430	1,532 5 0		...	
,, $2\frac{1}{2}$ per cent. on £26,262	...		656 10 0	
Regulating gear: 10 per cent. on £500	50 0 0		...	
,, ,, 10 per cent. on £2,500	...		250 0 0	
		4,683 5 0		4,086 10 0
		11,939 13 0	...	8,598 10 0
2,100 units × 365 days = 766,500 units. Cost per unit		3·75d.		2·7d.

I have based the statement I have before made, that the question of electric light supply companies becoming dividend-paying concerns, depends almost entirely on the number of houses joined on to the mains. The Tables, which are based on the supposition that two houses out of every three fronting the mains will take the light, show that capital invested in plant ought to earn a dividend of at least 10 or 12 per cent. after putting aside sufficient reserve fund to meet depreciation and all such charges. The two Tables, Nos. 1 and 2 (p. 740), show you the cost of having 100 yards of double conductor underneath the footway of a London street, Table 1 by means of insulated conductors drawn into bitumen casings, and these figures will hold good if iron pipes or wood troughing filled in with bitumen are employed. Table 2 shows the cost of having similar conductors in bare copper strip insulated by porcelain insulators in the culverts. You will see that whereas in Table 1 the price per lb. of copper laid complete varies from 4s. 1d. down to 2s. 6¼d. for heavy conductors according as the section is increased, in Table 2 the cost for equal sizes varies from 3s. 6d. down to about 1s. In both cases you will notice what an important part the cost of taking up and replacing the pavement bears to the whole cost of laying the conductors.

In conclusion, I have gone as rapidly as possible over the various matters which are affecting the introduction of the electric light into your houses, I have endeavoured as far as possible to adhere strictly to the subject of the paper, although in many cases sorely tempted to describe to you the various improvements and novelties that have taken place in connection with this most interesting subject. If, however, I have succeeded in bringing home to you what a powerful factor in the success of electric lighting is the intelligent co-operation of the public themselves who want the light, I shall feel that I have succeeded in my object.

DISCUSSION.

Surgeon-Major INCE said that having travelled a good deal in America, he was quite astonished when he came back to England to find how little the electric light was used here. There, he was told, that there was no town of 1,000 inhabitants which had not the electric light, and it was a reflection on the English that they should be so far behind. One of the greatest anomalies of the present day was the Electric Lighting measure, which seemed to show a great desire on the part of some people to prevent the introduction of electric lighting. The only point on which he differed with Mr. Crompton was where that gentleman threw a doubt on the possibility of the electric light being supplied by primary batteries, for he saw no reason why the electric light might not in the future be easily and profitably produced by chemical means.

General WEBBER said they were much indebted to Mr. Crompton for the admirable way in which he had brought forward this subject. He had had the pleasure of hearing Mr. Crompton deliver a lecture upon the same subject, but from another point of view, and could not but admire the way in which he refrained from pressing on the present audience the purely scientific and technical aspect of the case, but rather had shown how this industry was to be practically applied in the future. The load diagram on the wall was especially interesting, and showed clearly the saving obtained by the use of accumulators, which enabled them to get over a great difficulty which must be apparent to all who had thought on the subject, and had deterred many from investing in these undertakings. When gas was first manufactured for the purpose of distribution—as he had once heard from Dr. Letheby—one of the great difficulties was in making good gas-holders, and he was strongly reminded of that by the diagram he had referred to. He believed he was right in saying that one of the early difficulties in the case of gas was, that it was not safe to distribute it directly from the retorts; but although it was made evident to gas engineers that holders were necessary, they were some time in making a good serviceable holder—he believed a great deal longer time than it had taken electrical engineers to meet the same want as regards electricity. He believed the accumulator of to-day was a wonderfully efficient, safe, and serviceable apparatus. With regard to the Act which had been so much blamed, he thought more had been laid on its shoulders than could fairly be ascribed to it. No doubt the selling clauses were most deterrent, but still one great difficulty of that Act had not been brought before the public sufficiently. He did not know whether those present had thought much of it, although it was not many years since that the *Globe* used to have an article on the subject nearly every month. He referred to the question of over-head wires. Although they had increased greatly since 1868, no legislation had been passed to control their extension, and now (the United Telephone Company having set the example), they had growing up over magnificent streets like Regent-street these ropes and cords crossing from side to side, and in every way making the sky hideous. He did not see how this could have gone so far except for the extraordinary conservatism of the English, which in this case he took to mean the love of doing nothing and saving trouble. The system had thus been allowed

to grow up, although every engineer knew it could never be the permanent system for large towns. The real reason for these overhead cables was to meet the exigencies of the companies who desired to carry their electricity to the most profitable points, just as the bee went to the flower in which there was the most honey. If, instead of following that course, they were obliged to carry the mains along the streets, for house to house supply, they would never think of resorting to those cables, and the absence of legislation on this matter, even in Lord Thurlow's Bill, was a great mistake. Even now the existing provisional orders were not any use to the undertakers owning them, simply because the regulations which compelled them to carry their wires underground imposed a far higher cost than was imposed on other adventurous companies who were carrying their wires overhead, without any Parliamentary powers. Parliament never intended, he was quite certain, that this undertaking should be crippled in an unforeseen way of that kind, and the sooner these overhead wires were controlled the better. He hoped those present would feel they had been enlightened as to an enterprise which must be a profitable industry in the future; and that they would go away feeling that electric lighting was not the unprofitable thing which most people believed, and that they would be ready to put their money in an undertaking such as Mr. Crompton represented, and thus get the 10 per cent. they were all anxious to obtain.

Mr. Bromhead thought Mr. Crompton was under some misapprehension with regard to the fittings for electric lighting becoming necessarily the property of the landlord, as, at any rate, the fittings, such as were to be seen in that room, would belong to the tenant. Probably he referred more to the switches, wires, &c., but he should think engineers could devise means of fixing these in such a manner that they would remain the property of the tenant. He thought Mr. Crompton was also on the wrong tack in recommending heating by gas; he quite admitted its utility for cooking purposes, but it was very expensive for ordinary heating, and there were far better plans in operation in America and on the Continent, which were cheaper and more efficacious in avoiding dust and dirt, by the use of hot water apparatus. With regard to the systems of electric lighting in the United States, it must be remembered that there there were many advantages in its favour. In many towns there were no gas works in possession of the field when it was introduced, and it was also very common to have the power supplied very cheaply by water. In Godalming, electricity was supplied from dynamos worked by water power, and there it was almost, if not quite, as cheap as gas. In most places in England, however, it was necessary to use steam-power, and heavy rentals had to be paid.

Mr. Mordey thought Mr. Crompton had very wisely left the technical discussion of the relative merits of the two main systems of supplying electricity to another audience where he (Mr. Crompton) had dealt with it, but he might say that the figures he had given in the comparison between the two systems had been considerably reduced, as regards the alternate current Transformer System, by many of the speakers who had taken part in the discussion on Mr. Crompton's paper recently read before the Society of Telegraph Engineers. With regard to the very successful practice in America, he thought it was hardly brought out clearly enough that of the very large number of central stations now working there, not one (as far as he knew) relied upon accumulators. It was found quite possible and easy to work direct from the dynamos. In one very large undertaking, with this direct supply, the main had been kept supplied without stoppage or intermission for over five years. He thought this showed that too much was made of the argument that no moving machinery could be relied on for continuous supply. The Brush Corporation, with which he was connected, did a large amount of public, or semi-public, lighting —such as the Charing-cross Railway-station—by direct supply, without any difficulty whatever, and no one ever thought of providing any other than a mechanical reserve for such work. He thought accumulators were very good things in their place, but, speaking for himself, he did not think that place was a central station. For lighting mansions and other isolated places, where it was not desired to run the engines continuously, and for very many other purposes to which he would not refer, accumulators were of very great service, in fact, they were indispensable; but in the opinion of a very great number of electrical engineers, even in this country, their use in connection with public lighting was not by any means necessary. The great difficulty felt or feared in connection with the daily supply of the electric current on the transformer system was the idea that it would be necessary to keep the whole of the plant, or the greater portion of it, running the whole time, even when only a small amount of current was required; but they knew now that the machinery actually at work need not be greater than was actually necessary for the amount of work required. In the United States, at any rate, they were quite content with the substantial dividends they earned by direct-driving plant. He was glad General Webber had referred to the question of overhead conductors, which were very unsightly. Apart from legislative restrictions, the only reason generally given for their use was that the wires could not be put underground; that with high tension currents the insulation could not be made good enough to last any time. Experience, however, was against such a supposition. In early days conductors sometimes were not found to withstand high tension, but he could

mention cases in which wires, by no means well insulated, had been kept going for years, and supplied the light without interruption. For instance, in the lighting for the Corporation of the City, with which he was connected, the line put down, about 1880, from the works of the Brush Corporation in Lambeth, up to Cheapside and back again, was simply a gutta-percha covered wire drawn into iron pipes, not properly protected, in the way, for instance, which had been recently designed by General Webber. The insulation was far from perfect, mechanically and electrically, the jointing being very bad, and yet they were able to supply the electric light with those street mains for some six or seven years. Electricians might be surprised to hear that sometimes, when tested, the insulation resistance was not greater than the copper resistance, and yet they worked with a tension of nearly 2,000 volts, and managed to keep the circuit running. The wonder was, not that the line broke down occasionally, but that under such conditions it had ever worked at all. Since then a great deal had been learned about underground wires for very high tensions, and very many miles of such cables (in Eastbourne, Brighton, Milan, Tours, and other places) were now working satisfactorily, and there could be no doubt that, with the enormous improvements in the insulation of conductors and in laying them as, for instance, by the admirable method which Mr. Crompton had mentioned, which was, at least, good for moderate pressures, or the one of General Webber's which he had referred to, it would be quite possible to supply electricity by underground mains without any difficulty.

Mr. W. Lascelles Scott asked if Mr. Crompton had formed any opinion on the merits of the multiple conductor. Some years ago he obtained very good results, and had it not been for the Electric Lighting Act, he might possibly have done something with it, but that put a stop to everything. He thought one of the best means of obtaining the intelligent co-operation of the public in electric lighting was to introduce that light in every possible way, even if on a small scale; and on that ground he thought they ought to recognise the value of some of the primary batteries which were being brought forward, which obviated the necessity for laying mains at all, and by means of which you could get a very good light at a cost of from $\frac{1}{4}$d. to $\frac{1}{2}$d. an hour. In that way the public mind would be educated in the use of electricity on a small scale, and from that they would go on to larger things.

Mr. Beaumont Morice, as a member of the bar, had been rather surprised at the statement that electric fittings would always become the property of the landlord, though he knew that this was rather a bugbear to electrical engineers. He thought a little ingenuity on their part would enable them to overcome the difficulty, and bring the greater part of the fittings, at any rate, within the category of tenants' fixtures.

Mr. C. A. Swinburne said he was glad to find that Mr. Crompton did not intend to abolish gas altogether, but, as had been pointed out already, it was rather an expensive mode of heating, But it had other advantages, in the form of cleanliness and saving of labour, and he quite agreed that, on the whole, it was far superior to coal. The use of gas had been brought to such perfection by Mr. Fletcher, that you could do almost anything with it, and if people would only use it as it should be used—for warming and cooking—he thought it would be much better than using it for lighting purposes. There was still an enormous work to be done, without going quite so far as central-station lighting by electricity. The enormous residential buildings now springing up at the West-end would afford good opportunities, and each one would almost make a central station in itself. There would not be any trouble with the leads, and a very good profit could be made. One or two were being lit now, but there was no reason why the work should not be extended. The public had very little idea of the extent to which electric lighting was going on at the present moment. He had heard on good authority that no less than half-a-million incandescent lamps had recently been sold to customers in London, and that proved the spread of electric lighting. A great many people were on the look out for new inventions, thinking that electricity was going ahead so rapidly that all sorts of things were going to be discovered, but that was a pure delusion. The incandescent lamp—the use of carbon in a vacuum—was mentioned in 1836, and even in the dynamo there was very little which was new, it was simply made on a manufacturing scale, and made cheaper. He did not believe there was much improvement to be made in it, nor could much reduction be made in the cost of the leads; some reduction in price would come as the demand increased, but it could not be very large. People were continually talking about the difference between America and England, in respect to electric lighting, but, as had been remarked, in many of the small towns there was no gas, and, apart from that, America was much behind us in the gas manufacture, and what with the higher price of coal and labour, the average price was about 10s. per 1,000 feet, as against 2s. 9d. or 3s. in England. The Americans were a nation still developing, and were always ready to take up anything they considered useful; but a country like England, which had developed apparently as far as it was going, was more like continental countries.

Mr. H. Swan thought the favour with which gas had been received for heating purposes would to a great extent cease. It had been his opinion for a long time that a good deal of ill-health had been caused by the extraordinary dry heat of the

air which resulted from it. He believed that anyone with a sensitive nose could tell at once a house in which the cooking was done by gas. With regard to the use of overhead wires by the Grosvenor Gallery Company, and their picking their customers, no doubt that was to some extent the case, but Mr. Crompton would also have to pick his customers; he would have to take those who came to him. He had some connection with the Grosvenor Company, and he believed he might say that anyone on the line could be supplied, whether they wanted ten lights or two hundred.

Mr. G. L. ADDENBROOKE said overhead wires were looked upon with great disfavour from an æsthetic point of view, and all electrical engineers hoped to be able to do away with them, but at present they were in a transition stage; the question was not how to supply the electric light under perfect conditions, but to supply it at all. You might talk a great deal about the light, but if you wanted to get people to take it up you must put it before them. It was no use to tell them it was at the other end of London, or that if so many would join together and guarantee that so many would take it, a company should be started. They must know that somebody at the end of the street had the light, and then they would begin to think about taking it for themselves. Now, by running a system of overhead wires at high tension it was easy to do that, because you take a wire for a mile for the same money it would cost to take it 100 yards underground. From practical experience, he could say that where one house was lighted others would soon follow; but it was very little use attempting to introduce it unless some start had been made within a measurable distance. In the figures given, the cost of the mains came to something like a third of the whole outlay, but with overhead mains the cost would not be more than a third or fourth of that. In course of time, as electric lighting developed, they would be able to lay the mains under the street, but to do so at present would entail great difficulties. They could not tell how many houses would take the light, and must either guess at the number likely to take it, or expend a very large sum in copper which would in all probability never be repaid. With overhead conductors of high tension the cost of the copper was so small that it might be left out of the calculation. For instance, at about 2,000 volts tension, two hundred horse-power could be conveyed for a mile in cables of $\frac{19}{15}$ wires, equal to less than half an inch in section. The unsightliness of the overhead wires was due in great measure to the enormous number of different directions in which they ran. Every subscriber to the Telephone Company was in direct communication with the exchange, and the wire ran straight from his house to it; but that would not be so with electric lighting. The object there was to get a row of poles above the roofs on each side of the street, from which you could supply all the houses on either side, and to get across at the end you could go at right angles; in many cases the wires could be put so far back as to be invisible altogether. He did not think for a moment that the overhead system would be the permanent one, but the great thing was to get the lighting done. If they could get the majority of the houses in one street well lit, success would be assured.

Mr. T. W. FLETCHER said one important point had been lost sight of, and that was the question of reliability. At a lecture at St. James'-hall the light suddenly went out, and Messrs. Mappin, who had the light laid on just before Christmas from the central station, found that just when they wanted it most, he believed on Christmas-eve, there was none to be had. He knew one firm decided not to employ it on account of its uncertainty.

Mr. CROMPTON, in reply, said he agreed with almost everything Dr. Ince said, except his concluding observations about primary batteries. On that point he could only say that he adhered to the opinion he had expressed, in which he had every electrical engineer to back him. Those who believed in the likelihood of effective and cheap primary batteries were only imperfectly educated in electrical subjects, and their ideas, when translated into plain English, generally amounted to something very much like perpetual motion. The great evil was, that people not educated in the subject listened to these stories, and put off making use of electricity until they were realised. They forgot that one very large portion of the expense under any system must be the fixing of the wires in the house, and supplying the lamps and fittings. With regard to the legal question, he must repeat that for every £100 which need be spent, if plain ordinary lamps and fittings were used, £60 or £70 must be expended in wires and casings which must, in nine cases out of ten, be absolutely embedded in the walls, or affixed to them in such a way that they became the landlord's fixtures, and the Attorney-General had told him that he was perfectly right on that subject; of course the lamps and decorative fittings would belong to the tenant, but they formed a very small part of the cost. He cordially agreed with what General Webber had said about overhead wires. If they could be laid in the manner Mr. Addenbrooke suggested, and were taken longitudinally along the tops of the houses, and the crossings made at infrequent intervals at right angles, they would be much less objectionable. But that was just the way in which it was impossible to fix them, on account of the difficulty of getting way-leaves. There would always be some cantankerous gentleman who would spoil the whole plan, and you would have to cross the street and come back again. That was why the telephone wires were so unsightly in many cases. It was the obstructiveness of certain people which made the wires ten times as dangerous as they need be if their use were properly regulated. In America, where the wires were carried

along parallel to the street, they were, in nine cases out of ten, supported on wooden posts put up in the streets, and though Londoners were very patient, he did not think they would ever submit to that. A very little matter in the regulation of the service pipes would meet the difficulty. If they were in every case put down to the haunches of the cellar arches, so as to leave the space above the crown clear, culverts, such as he had suggested, could be constructed, in which the mains could be laid and attended to easily, and an additional quantity of wires added when required. A very good job could thus be made of it at a small expense comparatively. He thought it better to make suggestions which might be adopted, rather than bring forward propositions which he knew could not be realised. It was possible to arrange with the gas and water companies to regulate their small pipes, but he did not think it all likely that anyone would be allowed to put up posts in position, or to have overhead wires to any extent. On the question of heating by gas, no doubt it was expensive, because the gas was intended for lighting and not for heating; but if they took away the lighting from the gas company, they would find it to their interest to supply a larger volume of much cheaper gas, which would be equally effective for heating. He entirely denied the noxiousness of gas for heating, and the smell which sometimes escaped into the room could easily be avoided. If you put the gas-stove in the same position as a fire, and had a good draught in the chimney, you would no more have the products of combustion in the room than you would have smoke from an ordinary fire. And the same with gas-cooking. He had employed it for many years, and found that every servant who worked it infinitely preferred it to any other form of cooking apparatus, and there was no smell whatever. Mr. Fletcher's name would always be honourably connected with the utilisation of gas for heating, and almost all his apparatus could be worked without smell or danger, and with the minimum of trouble. One gentleman had referred to water-power, but that was hardly available anywhere in England; and the advantages gained by it were not very great. Modern improvements in the steam engine had made it so cheap, and the works for the utilisation of water power were so expensive, that the interest on the outlay would generally be nearly as much as the coal bill for the steam engine; for of a total of £9,000 a year only £2,100 went for coal. In some countries, such as Norway or Switzerland, where there were high falls on the rivers, water power might be economical, but he had not alluded to that because he was dealing chiefly with London. Of course the certainty of the light was a most important point; nothing did them so much harm as the light going out, and that was why he was so strong an advocate for accumulators; with them it was almost impossible for the light to go out suddenly. These might get out of order and give trouble, but it was always a gradual affair. He had the greatest sympathy with the Grosvenor Gallery people, whose difficulties, he believed, had arisen entirely from the sudden demands made upon them, and they must not criticise a company whose operations were extending at such a rapid rate. At Kensington they had worked for fifteen months, and had never found the light go out in any house since they started. They had reserved to themselves the right to turn off the current in the middle of the day for the purpose of making connections, but had never availed themselves of it, for they had always attached the mains, keeping the current on all the time; and that showed that the electric light could be made reasonably certain. The Grand Opera at Vienna had been lighted from the commencement without a hitch or extinction of any kind, and that was worked with accumulators. No doubt there was a controversy going on as to the two rival systems; and if Mr. Mordey would come to the Society of Telegraph Engineers on the following night, when he should reply to the criticisms which had been made on his paper on three successive nights, he hoped that that gentleman would be convinced by what he should then bring forward. He believed most of the large public buildings were going to be lighted by electricity, but that was not so interesting as the fact that every ordinary house might enjoy the same advantage. What he had endeavoured to point out was that it lay with the public themselves whether they would have the electric light; but if they wanted it they must not wait for the battery which would never come, and they must insist on vestrymen no longer throwing unnecessary obstacles in the way. He found that the bad example set in England was being improved upon in Paris, where the municipality had put forward what they called a *cahier des charges*, which was the most ridiculous document ever put forward by a body of sane individuals. The unfortunate man who was to take the contract was to pay through the nose for laying the conductors, to pay a percentage on his income, and was then limited in price, and in tenure; whereas the gas company could charge what they pleased, were not limited to time or price, and would not have to hand over their property at the end of eighteen years, as was the case with the electric lighting company. If the faults of the Electric Lighting Act were due to the conservatism of England, they had been excelled by democratic France.

The CHAIRMAN then proposed a vote of thanks to Mr. Crompton, which was carried unanimously.

Miscellaneous.

PARIS EXHIBITION.

The covered area of the Paris Exhibition, to be held in 1889, will not be greater than that of 1878, but the arrangement of the buildings and their

general character will be widely different. In 1878 there was a large number of structures in the Champ de Mars; next year there will be but few, but these will be on a much larger scale than anything that has been before attempted.

In fact, the leading characteristic of the 1889 Exhibition will be its monumental engineering. The general plan is extremely simple, and may be explained in a few words. Opposite the Ecole Militaire is the great Machinery Hall, 1,300 feet long, about 450 feet wide, and 150 feet high. The centre of this hall and the centre of the Eiffel Tower, at the opposite end of the enclosure, correspond with the axial line of the Champ de Mars, and of the Trocadero on the opposite side of the Seine; the Machinery Hall will practically occupy the whole width of the Champ de Mars. On the Ecole Militaire side a space between the building and the boundary fence will be left sufficiently wide to provide room for the boiler-houses, which are to supply steam for the motive power for driving exhibited machinery. From the centre of the great hall, and at right angles to it, a broad gallery will lead to the vast buildings devoted to miscellaneous exhibits, which extend to right and left for the whole width of the Champ de Mars, with wings of the same dimensions as the main portion, so arranged that a large open space is inclosed, being surrounded on three sides by these buildings. Beyond are the great Fine Arts Palace, the Palace of the Liberal Arts, the press and telegraph building, &c., and the Eiffel Tower. Between the galleries for miscellaneous exhibits and the Machinery Hall large spaces exist practically separated from each other by the transverse gallery running from the Machinery Hall, of which mention has been already made. These spaces will be occupied, on the one hand by the installation of the electric lighting syndicate, and on the other side by the building for railway exhibits.

The large parade ground which occupies the same relative position to the Hôtel des Invalides, that the Champ de Mars does to the Ecole Militaire, will be entirely absorbed for exhibition purposes; it will be used partly for French colonial displays, including exhibits of Algerian and Oriental products, native villages and industries, and partly for the exhibits of the French Government departments. The Esplanade des Invalides and the Champ de Mars will be connected along the Quai d'Orsay by two wide ranges of galleries that will be occupied by agricultural implements and products, food exhibits, &c.

The Palace of the Trocadero will be only partially utilised for exhibition purposes, but the extensive grounds which slope from the building to the river will be included, and several large pavilions will be erected on them devoted to horticulture, agriculture, forestry, and similar subjects. The Pont de Jena will serve as the connecting link with the Champ de Mars, as in 1878, but it will not be widened next year as it was on the last occasion.

The Exhibition buildings are in a very advanced condition, and with the favourable weather now prevailing, very rapid progress is being made. The buildings of the Galeries Diverses are practically completed, the ironwork of the Palais de Beanx Arts is well advanced, the press and postal buildings are nearly finished, and the foundations for all the work are in place. The Eiffel monument has been raised to one-third of its vast height, but it is quite impossible to form an adequate idea of its proportions, although even now it towers high above all the surrounding buildings, and is a conspicuous object from the Place de la Concorde. Of the Machinery Hall, three principals only are in place, but these are sufficient to give a good idea of what the building will be when completed, and of the vastness of its proportions. No such building has ever yet been attempted, and the beauty and simplicity of its design are as striking as its immense width and height.

Only a portion of the buildings and grounds will be lighted and opened to the public at night. But the area so treated will involve the expenditure of 3,000 electrical horse-power as a minimum. The supply of this power has been syndicated, the total having been divided into 300 shares of 10 horse-power each, the price for which to manufacturers joining the association is 1,000 francs per share. The capital thus formed—£12,000—will be devoted to the supply of power to each member of the syndicate, in proportion to what he has subscribed for, but all leads, lamps, cost of erection, and maintenance, will be at his charge. The syndicate will have the monopoly of furnishing the whole of the artificial lighting, and each member will be paid by the Committee *pro rata* for the light furnished by him. To obtain the necessary revenues for such payments, those parts of the Exhibition that will be opened to the public at night, will be handed over to the syndicate, who will charge two francs for admission. Of this, 50 per cent. will be given back to the French executive, and the remainder will be available for distribution between the members of the syndicate.

Naturally, the restaurants will be open at night; they will be very suitably arranged around three sides of the central garden inclosed by the galleries of miscellaneous exhibits. As this garden is already planted with quite large trees, and will be laid out attractively, it may readily be supposed that this part of the Exhibition will be crowded nightly, and that the space set apart for the restaurants will not be too great. In connection with this subject we may mention that no coal fires will be allowed, so that all cooking must be done with gas.

The buildings along the Quai d'Orsay, which will connect the Champ de Mars and the Esplanade des Invalides, are being well pushed forward. They will occupy much the same position as in 1878, but, like all the present Exhibition structures, they appear to be more elaborate and costly. On the Esplanade des Invalides work has already commenced. Here will be some of the most important of the Government department exhibits, and large credits are being

asked for and given for this purpose. Thus the other day 8,000,000 francs was voted to defray the cost of the exhibit of the Ministry of Trade and Commerce.—*Engineering.*

BRAZILIAN COFFEE.

The empire of Brazil has attained the supremacy in the production of coffee over every other country of the world. A century-and-a-half of attention to this staple industry has enabled the coffee planters to throw on the markets of the world more than one-half of all the coffee produced. The culture is carried on more or less largely from the River Amazon to the province of San Paulo embracing nearly 20 degrees of latitude. From the coast to the extreme west of the province of Matto Grosso comprises 25 degrees of longitude. Coffee, however, succeeds best generally between the 18th and 25th parallels. Brazil will merit the name of the coffee country *par excellence*, seeing that it produces more than 250,000 tons annually. Brazilian coffee is divided into eight kinds, which take the names of the districts in which it is cultivated, viz., Rio, Santos, Bahia, Ceara, Minas-Gevaes, Andaiahy, Pernambuco, and Amazon. Fifty-five per cent. of the coffee exports are shipped from the port of Rio. The total exports from Rio have been in—

	Bags.
1840	1,068,418
1850	1,343,484
1860	2,127,219
1870	2,209,456
1880	3,513,368
1886	4,209,200

The weight of the Brazilian bags of coffee vary, in Rio they are 160 lbs., in Bahia 128 lbs., but the average may be taken at 1¼ cwt. The total exports of Brazilian coffee last year were a little over 6,000,000 bags.

What is singular is that in Europe, although half the production goes there, Brazilian coffee is never seen or heard of as sent. It is passed off in trade circles under other names. A prejudice seems to exist against it which leads to this commercial deception, and yet Brazilian coffee has greatly improved of late years both in culture and preparation. In the amount of caffeine it contains it compares favourably with other coffees. The following proportions have been found:—

Yellow coffee of Brazil	1·82
Java	1·79
Mocha	1·26
Cayenne	1·00
St. Domingo	0·89

An analysis made by Prof. Church a few years ago for the Brazilian Government gave 1·18 per cent.

At the different International Exhibitions in Holland, Belgium, the United States, and Russia, Brazilian coffee has obtained the highest awards, and the Agricultural and Commercial Society of Rio Janiero has taken great pains in the interest of the coffee planters to diffuse useful information, and to obtain justice for their coffee. The principal error appears to be in throwing the produce on the market in too green a state. Unlike tea, which should be used as soon as possible, coffee, like wine, improves with age, and the longer the berry is kept the better, as the moisture is evaporated and the quality is improved. But neither planters nor dealers can afford to store the coffee for any length of time, and incur the loss in weight and expenses—hence the rawness of the coffee, and the objection to its general use, except in the United States.

The Brazilian planters, with the growers in British possessions, are suffering from the gradual fall in prices during the last eight years, and the more general use of tea, in many countries. In England, the consumption of coffee has naturally declined. Ten years ago it was about 1 lb. per head of the population; now it is only 0·86 of a pound, whilst the proportion of tea is 5 lbs. This decline in coffee may arise from adulteration, for 100,000 cwts. of foreign chicory is imported, besides what is grown at home, and cocoa is more popular. If we take the latest year available (1886), the following were the quantities of coffee imported for consumption by different countries, compared with the population, which is given for the years named:—

Countries.	Population.	Coffee Imports in tons.
France, 1886	38,218,903	68,233
Belgium, 1880	5,520,009	26,874
Holland, 1879	4,012,093	84,144
Switzerland, 1880	2,846,102	9,764
Russia in Europe, 1882	87,407,721	7,330
Sweden, 1886	4,717,189	15,453
Norway, 1885	1,947,000	8,814
Denmark, 1880	1,969,039	770
Germany and Hamburg 1885	46,855,704	2,367,305
Austro-Hungary, 1880	37,883,503	37,559
Roumania, 1884	5,173,452	1,400
Greece	1,719,301	—
Italy, 1881	28,459,628	10,851
Portugal, 1878	4,348,541	2,633
Egypt, 1882	6,806,381	17,504
United Kingdom, 1881	35,003,719	50,327
United States, 1880	50,155,783	252,102

After the United States, which consumes 10½ lbs. per head, Belgium, Holland, Denmark, the Scandinavian States, and Switzerland are the largest consumers of coffee.

Correspondence.

LOCKS AND SAFES.

Mr. Chatwood states that I am to be invited to attempt to open a strong room of a Lancashire bank at my own cost, with "my" burglar's appliances, in "my" burglar's bag. He is evidently under some delusion in the matter. I am neither an amateur nor professional burglar, nor have I any burglar's appliances, not even a burglar's bag. If Mr. Chatwood will call to mind our conversation he will remember that I told him where he could buy a silent blow-pipe and compressed gas, which would fuse a slot in a $\frac{3}{8}$ in. thick compound drill-proof plate, at the rate of about two inches per minute, this plate being what Mr. Chatwood himself used in a safe supplied to me. He is perfectly aware that I do not make the silent blow-pipes, but the maker's name and address was given to him, along with that of the Brin Oxygen Company, who supply both compressed oxygen and compressed hydrogen, and Mr. Chatwood is therefore in a position to carry out the experiments which he has so publicly stated his intention to ask me to carry out for him. I have no belief whatever in the possibility of penetrating the thick plates which are used for bankers' strong rooms, and my remarks to Mr. Chatwood applied only to such safes as he supplied to me, and such as are used in ordinary offices.

THOMAS FLETCHER.

Warrington, May 12, 1888.

I am glad to find that Mr. Fletcher agrees with the conclusions expressed in my paper respecting the use of his oxyhydrogen blow-pipe as a burglar's tool.

A great deal has been said as to the ability of burglars to open any safe with this appliance. It is now admitted that these statements are greatly exaggerated, and I am glad that Mr. Fletcher has thought fit to contradict the inferences which have been generally drawn from his experiments at Liverpool, when it was publicly stated that the instrument then used would open any burglar-proof safe. The safe to which he refers, which he purchased from me fifteen years ago for £11 10s., is not a burglar-proof safe, but simply a fire-proof safe, intended for ordinary office books, &c.

Mr. Fletcher is in error in supposing that he has informed me where a silent blow-pipe can be purchased, and my experiments have been carried out with a blow-pipe supplied by himself, and which was far from silent. I have now written to Mr. Fletcher, asking for this information, and I shall be interested to know if the silent blow-pipe is as efficient and portable as the one with which my experiments have been made.

There will, of course, not now be any necessity to invite Mr. Fletcher to operate upon the bankers' strong room, as the object aimed at is secured by his letters to the Press.

SAMUEL CHATWOOD,
Bankers' Engineer.

76, Newgate-street, London,
May 16, 1888.

THE PLACE OF DRAWING IN EDUCATION.

In the formative system of education, drawing takes its proper place as the gymnastic of the sense of sight, as it doubtless did in the Grecian system of training, for we are told that drawing and music were taught in all the Grecian schools 400 B.C. The Greeks, contemplating the success of a formative system of training in their athletic games, with shrewd common sense perceived that the gymnastical system might not only be applied to the proportionate development of the body, but also to the just development of all the faculties, and of course to the sense of sight, by the practice of drawing. Everybody now knows with what splendid results this system of formative training was crowned. Instead, however, of following so good an example, we are in England trying by every means in our power to destroy the true proportion of the faculties themselves, and of the faculties *inter se*, by compelling the cramming of all kinds of knowledge into the brain. Educationists seem to forget that it is the power of using knowledge, rather than the piling up of immense stores of information, that they should strive to promote. Moreover, they have yet to learn that every science and ology committed to the brain is an equivalent of a certain amount of vital energy expended, and that in the same ratio that the number of studies is increased, do we near the verge of nervous power, whereas the true object of education should be, not only to give the student the power of utilising any kind of knowledge, but to leave him with a sufficient reserve of vital energy to pursue whatever he may desire to pursue.

W. CAVE THOMAS.

8, Fitzroy-street, W.,
May 12, 1888.

Obituary.

SIR CHARLES BRIGHT.—Sir Charles Tilston Bright, a member of the Society of Arts since 1863, died on Thursday, 3rd inst., at his residence 78, Philbeach-gardens. He was born in 1832, the youngest son of the late Mr. Brailsford Bright, the head of an old Yorkshire family long settled in Hallamshire. Charles Bright was educated at the Merchant Taylors' School, and from his schoolboy days he turned his attention to electricity and chemistry. He was, from the age of 15, engaged with the Electric

Telegraph Company, and worked for some years, under Sir William Fothergill Clarke, in introducing and developing telegraphs for the public service. In 1852, he was appointed engineer in chief to the Board of the Magnetic Telegraph Company, in whose service his elder brother Edward had been acting as manager for some years. The two brothers at once worked together and patented a series of inventions in connection with telegraphic apparatus. While he was working out these inventions, he was also engaged in practical work in laying down lines in many parts of the United Kingdom, and he was the engineer who laid down the first cable which united Great Britain with Ireland, in 1853. In 1858, as engineer-in-chief, he successfully laid the first Atlantic cable. The cable was made in England, and the laying of over 2,000 miles was completed in August, 1858, after eight days of work, during which the four ships engaged, which were lent by the British and United States Governments, had to bear the brunt of a violent storm in the middle of the Atlantic. After this service Mr. Bright was knighted by the Lord-Lieutenant of Ireland. After carrying out a few operations in submarine telegraphs in the Mediterranean and in the Baltic, he was summoned, in 1864, by the Government of India to complete the communication with Enrope, which work he personally superintended and accomplished by joining Kurrachee with the northern end of the Persian Gulf. Within the next few years he superintended the laying of cables between the United States and Cuba, and united various parts of North and South America, the West Indies, and other places. In a paper read by him at the Institution of Civil Engineers in 1865, he advocated submarine telegraphs to China and Australia, and for this paper he received the Telford gold medal of the institution. He was Vice-President of the Society of Telegraph Engineers, and a member or Fellow of several learned societies. He was elected member of Parliament for Greenwich in 1865, and continued to represent that place for several years in the Liberal interest. In 1881, he was appointed by the Foreign Office as Commissioner with the Earl of Crawford and others to represent this country at the French International Exhibition, and he was in consequence nominated an officer of the Legion of Honour. Last year, at the meeting of the Society of Telegraph Engineers and Electricians, Sir Charles Bright delivered the inaugural address, in which he dealt exhaustively with the whole subject and history of the telegraph during the past thirty years.

General Notes.

City and Guilds of London Institute.—During the month of July, 1888, the following courses will be held in the Institute's new buildings, in Exhibition-road:—1. "Elementnry Principles of Machine-Designing," by Professor W. C. Unwin, F.R.S.; daily, Saturdays excepted, from 6.30 to 8 p.m., and extending over a fortnight, commencing on Monday, July 2nd. 2. "Practical Lessons in Organic Chemistry, intended mainly for Teachers of Technological Subjects," by Professor Armstrong, F.R.S., Ph.D.; this course will extend over two weeks, from 10 till 4 daily, commencing on July 2nd. 3. "The Construction and Use of Electrical Measuring Instruments," by Professor Ayrton, F.R.S.; six lectures, from 8 to 9 p.m., on Mondays, Wednesdays, and Fridays in the fortnight commencing on Monday, July 16th; and also of practical work in the physical laboratories, daily, from 2 to 5 p.m., Saturdays excepted. 4. "Experimental Mechanics," by Professor Henrici, Ph.D., LL.D., F.R.S.; will extend over two weeks, from 10 to 4, commencing on Monday, July 16th. 5. "The Principles of Bread Making," by William Iago, F.C.S., F.I.C.; will extend over two weeks, from 10 to 4 daily, Saturdays excepted, commencing on Monday, July 16th. 6. "Photography," by Captain Abney, R.E., F.R.S.; six lectures, at 8 p.m. on Monday, Wednesday, and Friday, commencing on Monday, July 2nd. 7. "Mathematical and Surveying Instruments," by Arthur Thomas Walmisley, M.I.C.E.; six lectures, at 8 p.m. on Monday, Wednesday, and Friday, commencing on Monday, July 2nd. 8. "Gas Manufacture," by Lewis T. Wright, Engineer to the Nottingham Gas Works; four lectures, at 8 p.m., on Tuesday, July 17th; Thursday, July 19th; Monday, July 23rd; and Tuesday, July 24th. 9. "The Application of Modern Geometry to the Cutting of Solids for Masonry and other Technical Arts," by Lawrence Harvey; six lectures, practically illustrated, at 8 p.m. on Monday, Wednesday, and Friday, commencing on Monday, July 16th. 10. "The Craft of the Carpenter," by John Slater, B.A.; four lectures, at 8 p.m., on Tuesday, July 3rd; Friday, July 6th; Tuesday, July 10th; and Friday, July 13th. A syllabus of each course may be obtained at the Central Institution, Exhibition-road, S.W., or at Gresham College, London, E.C.

Coal-tar Dyes.—The value of these imports in the last three years has averaged half a million sterling. The imports in 1886 were:—

Aniline	£246,032
Alizarine	260,834
Other coal-tar dyes	1,623
	£509,750

These dyes are largely replacing lac dye, and the various native vegetable dyes in India. The imports of cochineal have also largely declined. The imports last year were under 10,000 cwt., against 14,710 cwt. in the previous year. The Canary Islands are almost the only producers.

Journal of the Society of Arts.

No. 1,853. Vol. XXXVI.

FRIDAY, MAY 25, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, June 20th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

The cards of invitation will be issued shortly.

MEDALS AT THE NATIONAL CO-OPERATIVE EXHIBITION.

A National Co-operative Exhibition will be held at the Crystal Palace in August of the present year, in connection with the Co-operative Union, and at the request of the Central Board of the Union the Council of the Society of Arts have decided to offer bronze medals to exhibitors in the following classes of the Exhibition, and also to appoint judges:—

Class 1.—Engineering.
,, 2.—Art metal work.
,, 3.—Metal work (general).
,, 4.—Weaving (textile manufacture).
,, 5.—Joinery.
,, 6.—Cabinet-making.
,, 7.—Printing and lithography.
,, 8.—Bookbinding.
,, 9.—Engraving on wood and metal.
,, 10.—Watchmaking and turret clocks.
,, 11.—Cutlery.
,, 12.—House decorating.
,, 13.—Painting on glass, china, and pottery.
,, 14.—Stone, wood, and other carving.
,, 15.—Leather work (including portmanteaus).
Class 16.—Boot and shoemaking.
,, 17.—Tailoring.
,, 18.—Basket and small ware.
,, 19.—Pottery.
,, 20.—Jewellery.

One bronze medal is offered in each class.

EXAMINATIONS, 1888.

The list of successful candidates in the Examinations for the present year has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies will also be sent to the various Committees for the successful Candidates.

MAP OF CANALS.

With the next number of the *Journal* will be issued, as a supplement, a map of the canals of England, by Messrs. G. Philip and Son, intended to illustrate the papers of the Canal Conference now being published in the *Journal*.

Proceedings of the Society.

CANAL CONFERENCE.

Thursday, May 10th, 1888, Sir Douglas Galton, K.C.B., F.R.S., Chairman of Council, in the chair.

OPENING ADDRESS.

By Sir Douglas Galton, R.E.. K.C.B., F.R.S., &c.
Chairman of Council.

The Society of Arts deemed that the present time was a convenient one for a Conference on Canals and Inland Navigation, for various reasons, of which I will mention two. In the first place, there are now impending important changes in the local administration of the country, which, amongst other matters, will have an influence on the maintenance of our roads. And in the second place, a measure is now before Parliament for regulating the condition of railway traffic. Whilst thus the attention of the country is directed to two of our means of communication, the Society considered that it was a desirable opportunity to draw special attention to the third, namely, our canals and inland navigation, which have almost slipped out of public notice of late years, but which, if they could

be rehabilitated, and placed on an improved basis, might again become of material value to the country. No doubt the Railway Rates Bill is intended to include, to some extent, the regulation of the traffic on canals, but the conditions of canal traffic are totally different from those which govern railway traffic; for except in a few cases, the canal partakes more of the nature of a highway than a railway does. For instance, as a general rule, any person may take his boat along the canal on paying the regulated toll. The canal company does not itself work the traffic. There are no doubt some exceptions to this; but even when the owning company works the traffic, other boats can work on the canal without any of those dangers which would result if unregulated traffic were allowed on a railway. There have been in all some 4,000 miles of inland navigation in Great Britain. Of these, canal companies own 1,445 miles; public trusts, 927; and about 1,333 miles are under the control of railways. Of the canals under the control of railways, above 1,000 miles passed under that control before 1853. In that year the first Railway and Canal Traffic Act was passed by Parliament, with the object of obtaining a control over railway traffic. Since that period, it may, I think, be said that Parliament has, with tolerable consistency, endeavoured to preserve the canal communication of the country free from the control of railways; and, therefore, the number of canals owned by railways has not materially altered in late years. In the Appendix to the Report of the Select Committee on Canals, of 1883, there is a table given of some 21 different through routes by canal, between important trade centres, but of these, only five are independent of canals owned or controlled by railways. Moreover, the gauge of the canals is not uniform. The locks of the Aire and Calder allow of the passage of boats of 212 feet long, and 22 feet broad, whilst on other canals, or navigations, there are locks which only admit boats 70 feet long, by 7 feet wide. The canals have also been much neglected, and indeed, in many cases, suffered to fall into disuse; and there are 188 miles of canal now derelict. In one instance, it is stated that a canal not derelict has been allowed to choke up with mud; and some 119 miles of canal have been converted into railways. Thus, whilst we have applied a large amount of engineering skill to railways and to docks, we have left our canals much in the same condition that they were fifty years ago—except, possibly, that in many cases they are in a worse condition. The reason is obvious. The character of our railways has continually improved because the competition has been keen and continuous; and, moreover, the railways near the coast have been subjected to water competition by the coasting trade, in which the vessels are comparatively large and the tolls or dues insignificant, and that competition by sea has, to some extent, reacted on the inland rates charged on traffic. But where the inland railways have come into competition with canals, in addition to the unfavourable conditions of construction prevailing on the canals, which so greatly limits the size of the boats, the canals have been frequently weighted by the fact of some link in the chain of canal communication having passed into the hands of a railway, and the power of the canals to compete has thus been nullified. Again, there are many anomalies of classification in the tolls authorised by Parliament to be charged on different canals forming part of a through route; and without uniformity of classification the difficulties of arranging through rates on contiguous canals are much enhanced. Thus, you will see that we in England have practically ignored our canals for the last fifty years; but when we turn to the Continent of Europe and to America we find that the Governments of France, Germany, and Belgium have been much more alive to the importance of water communication; these Governments have acquired, and are improving, their principal water routes with very great advantage to the public welfare; and in the United States water communication continues to hold its own, and on many important lines of communication it affords an important check upon the rates of traffic carried on railways. The whole experience of inland navigation in Europe, in America, and in this country, shows that if the transit by canal is to be cheap the canals and the locks must be of adequate size; for whilst, with small boats, competition with a railway is impossible, large boats, on the other hand, would enable goods to be conveyed by canal at a figure which railways would find it difficult to underbid. The cost of carriage is so important an element in cost of production and in profit, that the question may very usefully be raised as to how our waterways can be best regulated, so as to afford the relief so much required by our national industries, under the new conditions of competition

to which they are exposed from the increased production of foreign countries, and the very low rates at which these foreign products are delivered in this country. Sir Michael Hicks-Beach, and Mr. Gladstone, in a recent debate, whilst repudiating the idea of the State-purchase of railways, throw out the idea that the State might purchase the canals mainly apparently on the ground of their conditions of traffic approximating rather to those on a turnpike road, than to the conditions of railway traffic. The State-purchase of canals would, no doubt, be a much simpler operation than the purchase of the railways; and it is quite possible that some scheme for their maintenance and management might be devised under the new county councils. On the other hand, our great engineering successes have hitherto always been obtained under the stimulus of private enterprise; and there is always a fear that when the State steps in the actual position becomes stereotyped. Advance is checked, and the enterprise is stunted. My remarks are, however, intended only to pave the way for a discussion; it is not my function to formulate propositions. That is the function of the readers of the several papers. We have received fifteen papers to be read at the Conference, which may be classed as follows under the subjects enumerated in our programme:—

History, rise, and progress of canal and inland river navigation in Great Britain and Ireland. Papers by Mr. M. B. Cotsworth and Mr. G. Lester.

Canal engineering, past and present; uniformity of gauges, systems of haulage, methods of construction, locks, hydraulic and other apparatus for raising and lowering barges, water supply, &c. Papers by Mr. G. R. Jebb, Mr. Leveson Francis Vernon-Harcourt, and Mr. Edward John Lloyd.

Present condition of canal navigation in Great Britain and Ireland; suggestions for its improvement. Paper by Mr. M. B. Cotsworth.

Canals and railways—their mutual influence on each other. Paper by Mr. Urquhart A. Forbes.

Comparative cost of transport by railways and by Canals. Papers by Francis Roubiliac Conder and General Rundall.

The Law of Canals, and matters relating thereto. Paper by Mr. A. B. Kempe.

We have in these papers, in a collected form, the views of gentlemen who have given much consideration to the subject of our canals, and I trust that the reading of the papers, and the discussions thereon, will afford a thorough ventilation of the important subject of inland navigation.

CANAL ENGINEERING; ITS PAST; ITS PRESENT AIMS; AND ITS PROSPECTS IN THE FUTURE.

By Leveson Francis Vernon-Harcourt, M.A., M.Inst.C.E.

When canals were carried out extensively in England in the latter half of the last century and the beginning of the present century, no other mode of conveyance existed, beyond the ordinary traffic along the roads, to enter into competition with them. These canals, moreover, were constructed at a period when little experience existed of public works on a large scale, and in the absence of most of the appliances which would be considered essential in the present day. For instance, the first Harecastle Tunnel, $1\frac{5}{8}$ miles long, occupied 11 years in construction, two years more than the St. Gothard Tunnel, $9\frac{1}{4}$ miles long, through the hardest rock, and only capable of being driven from the two extremities.

Uniformity of Gauge.—The canals, both in England and on the Continent, were mainly carried out with a view to local traffic, and in conformity with the special physical conditions of the site, and not with the object of forming lines of inter-communication from one end of the country to the other. Hence arose the great diversity of depth, and in the dimensions of locks, which has proved such a hindrance to the extension of traffic on canals and canalised rivers. The importance, indeed, of uniformity of gauge was not fully understood in the early days of railways, and therefore it is not surprising that it was not realised during the extension of canals more than half a century before. When, however, railways were introduced, giving passengers and perishable goods the rapidity of transit which the canal system was not calculated to afford, they quickly rose in public favour, and drew away from canals the heavy traffic in bulky goods, which, if the canals had possessed uniformity of gauge, and had been adapted for barges of suitable capacity, and for steam haulage, they might have carried with benefit to the community. The establishment of railways lowered canals in public estimation in England, and, except in a few special instances, re-

moved the confidence which would have been essential to enable the necessary capital to be raised for carrying out the required works of improvement. The railway companies, moreover, by becoming the proprietors of important links in the canal system, barred the way to future improvements, which, as soon as the rush after railways had subsided, might have been introduced along the main lines of canals, and prevented the amalgamation of the several canals along each route, which would form a necessary preliminary to any definite scheme.

The size of craft which can traverse a through route depends on the least navigable depth in the canal and over the sills of the locks, and the least width and length of any lock along the route. Unfortunately, very few through canal routes exist in England which are not obstructed by some narrow locks, or shallow portions of canal, rendering the comparatively good width and depth of the remainder quite unavailable for a larger craft. In France, the same want of uniformity of gauge on the waterways existed; but as almost all the waterways are under the control of the State, improvements and extensions have been constantly in hand; and in 1879, a law was passed for providing a uniform depth of 6½ feet, locks 126⅝ feet long and 17 feet wide, and a clear height of 12 feet under the bridges, throughout the principal lines of waterways of France. The works for securing this uniformity are being gradually carried out; and when they have been completed, 300-ton barges, 126⅓ feet long, 16½ feet wide, and 6 feet draught, will be able to traverse all the principal waterways of the country.

The depth of English canals ranges, for the most part, between 3½ feet to 5 feet; but the Severn navigation to Gloucester affords a depth of 6 feet; the Gloucester and Berkeley Canal, 15 feet; the Aire and Calder navigation, 9 feet; and the Forth and Clyde Canal, 10 feet. The locks range in size from 72 feet length, 7 feet width, and 3½ feet depth of water over the sills, up to 215 feet by 22 feet by 9 feet on the Aire and Calder navigation.

Enlargement of Waterway.—On navigations like the Aire and Calder, which, from their independent position and their suitable situation for the conveyance of heavy goods, have been enabled to compete successfully with railways, it has been found expedient to enlarge the waterway, in order to meet the demand for increased draught and more economical carriage in larger barges. Thus the Aire and Calder navigation, which originally was 3½ feet deep, with locks 60 feet long and 15 feet wide, was deepened to 5 feet under an Act of 1778, and the locks made 66 feet by 15 feet by 5 feet. Under powers obtained in 1828, the navigation was deepened throughout to 7 feet, and the locks were enlarged to 72 feet by 18 feet by 7 feet; and since 1860, the navigation has been gradually improved to a depth of 9 feet, with locks of 215 feet by 22 feet by 9 feet, accommodating barges of 167 tons. A similar series of improvements have been carried out on the Welland and St. Lawrence canals, though on a larger scale, for facilitating the navigation between Lake Erie and Montreal through Lake Ontario; for these canals have been enlarged three times since 1825. The latest enlargement to a depth of 14 feet, with locks 270 feet long, 45 feet wide, and 14 feet deep, was decreed in 1875. The Welland Canal, having been given a depth of 14 feet, and a bottom width of 100 feet, and provided with locks of the above dimensions, was re-opened for traffic in 1882; and as soon as the works on the St. Lawrence Canals are completed, vessels of 1,000 to 1,500 tons will be able to pass from Lake Erie to Montreal. The canalisation of the Upper Seine, between Montereau and Paris, was only undertaken in 1860, whereby a depth of 5¼ feet was obtained; and yet in 1878, a further increase of depth to 6½ feet was decided upon. This improvement was mainly effected by raising the water-level in the several reaches, a plan adopted on the Forth and Clyde Canal for increasing its depth from 8½ feet to 10 feet, and also on some of the French canal improvements works, such as the Marne-Rhine Canal, where the depth was increased from 5¼ feet to 6½ feet, by raising the banks and the locks. The navigable depth on the Lower Seine has been successively increased to 5¼ feet, and 6½ feet; and works are now in progress for obtaining a depth of 10½ feet between Paris and Rouen, suitable for vessels of 800 to 1,000 tons.

Locks.—The sizes of the locks regulate the dimensions of the barges which can navigate a waterway; but whereas the deepening of a navigation by dredging may generally be effected at a moderate cost, the enlargement of locks, necessitating in most cases their reconstruction, forms a very important item in the expenditure on the improvement of a waterway. The enlargement of the smaller locks for securing uniformity of gauge, and the lowering of the sills of the wider locks, as well as the deepening and widening of the

waterway to a uniform section throughout, would form an essential portion of any scheme for opening up through canal routes.

In addition, however, to uniformity of size in locks, it is important that the time occupied by a vessel in passing through a lock should be reduced as much as possible, as this period forms a notable proportion of the time of transit where the locks along the route are numerous. The time occupied in passing through a lock on the French canals used to amount to from 16 to 20 minutes at least. The time is spent in filling or emptying the lock, in closing and opening the lock-gates, and in passing the barge into and out of the lock-chamber. The adjustment of the water-level in the lock-chamber may be hastened by large sluices in the side walls of the lock. The moving of the lock-gates can be rapidly effected by hydraulic machinery. Delays have been experienced in dragging a barge into or out of the lock when it is nearly the width of the lock-chamber, owing to its acting like a piston, and preventing the flowing back of the water along the sides; but this inconvenience can be obviated by carrying the culverts for the sluiceways all along the side walls, and providing lateral openings through which the water finds an exit. Locks provided with sluiceways running the whole length of the side walls have been constructed on the Aire and Calder navigation, on the Scheldt and Meuse Canal, and the Canal du Centre of France. These large sluiceways ensure the rapid filling or emptying of the lock; and by making several side openings along the side walls into the lock-chamber, the inflowing or outflowing currents are distributed so as to have no injurious effect on the vessel inside. Balanced cylindrical sluice-gates, rising and falling vertically in a circular well communicating with the sluiceways, have been adopted at the new locks of these two foreign canals, for opening and closing the sluiceways easily and rapidly. The enlarged locks on the Canal du Centre can be filled or emptied in two minutes; and the passage of vessels through the locks takes less than half the original time.

Saving of water in lockage is an important consideration on many canals, where water is scarce, or where a supply has to be provided by the construction of large reservoirs, retained by dams across river valleys, especially as the expenditure of water increases with the traffic. Side ponds and double locks are well-known expedients for economising water, by reserving a portion at each lockage to be used again for refilling the lower part of the chamber, or by directing a vessel into one or other of the locks, according to the level of the water in the chambers.

M. de Caligny has made a series of interesting experiments at the Aubris Lock, on the lateral canal of the Loire, which have proved that a very large per-centage of the water can be saved, in emptying or filling a lock, by suitable arrangements for converting the *vis viva* of the water flowing through the sluiceways into a force for storing up a portion of the water, by suddenly and repeatedly changing the direction of its flow.

By providing two or three locks of different dimensions, and placing an intermediate pair of gates in the larger locks, it is possible to give accommodation for a considerable variety of traffic, together with economy in water, and saving in time of lockage for smaller vessels. Thus at Poses, on the Lower Seine, three locks have been erected of very different sizes, the largest being 524 feet by $55\frac{3}{4}$ feet, by $10\frac{1}{2}$ feet depth over sill; and the locks on the Manchester Ship-Canal are to be 500 feet by 60 feet, 300 feet by 40 feet, and 100 feet by 20 feet at the end of each reach, with intermediate gates in the two larger locks.

The largest canal locks hitherto contemplated are those designed by Col. Blackman, for the proposed Nicaragua Canal. They are 700 feet long, 100 feet wide, and with 30 feet depth of water over the sill; whilst the lift proposed is from 50 to 120 feet. The filling of the lock-chamber is to be rapidly effected through 18ft. cast-iron pipes, built into the side walls along the whole length on each side, connected across the bottom of the lock-chamber by a series of 3ft. pipes, perforated by a number of 2in. holes, from which the water will be distributed over the whole area of the chamber in numerous small streams, so as to avoid any prejudicial agitation of the water. The emptying is to be similarly effected; and where a saving of water is important, the pipes will discharge at the lower end into a series of long ponds, formed in terraces, so that most of the water may be used again for filling the lock. These arrangements are a large extension of the system of sluiceways, all along the side walls, with lateral openings, and of side ponds, already referred to. The most novel feature is the form of the caisson-gate, to be constructed of wrought-iron and steel, which, being increased in width towards the bottom, becomes stronger in proportion to the depth, as the water-pressure increases. More-

over, the weight of the water resting upon the wedge-shaped inner face, aids the weight of the gate in resisting the tendency to flotation, due to the head of water, when the lock-chamber is full. It is proposed to move the gate by the help of a turbine, worked by the fall of water from the upper pool.

Inclines.—In most cases, a considerable difference of level between two adjacent reaches has been surmounted by a flight of locks. Inclines, or lifts, however, would be preferable under such conditions, as either of these arrangements effect a great economy, both in time and water, as compared with flights of locks.

A canal incline consists of two lines of way, laid on a steep uniform gradient, on which barges are drawn up or let down, by wire cables, from one reach to the next, either resting on a cradle, or water-borne, in a caisson, running on wheels on the incline. The cables wind round a drum at the top of the incline; and the ascending barge is generally more or less counterbalanced by another descending, whereby the tractive force required to pull the barge up is considerably reduced. Primitive inclines exist on the Bude Canal in Cornwall; and some inclines were established on the Shropshire Canal towards the close of the last century. Inclines, however, up which barges are drawn in cradles, were carried out on the most extensive scale on the Morris Canal in America, where there are twenty-three inclines with gradients of 1 in 10, and an average lift of 58 feet. The largest of these is 1,100 feet long, and rises 100 feet; and barges of 70 tons are drawn up the inclines.

The first incline up which barges were conveyed in a large caisson containing water was at Blackhill, on the Monkland Canal, near Glasgow, the system having been previously introduced, on a small scale, on the Chard Canal in Somersetshire. The Blackhill incline, with a rise of 96 feet, and a gradient of 1 in 10, replaced two flights of four locks each. The wrought-iron caisson, 70 feet long and $13\frac{1}{2}$ feet wide, runs on twenty wheels, and carries barges of 60 tons on the incline. An incline with larger caissons was constructed at Georgetown in 1876, in substitution for two locks connecting the Chesapeake and Ohio Canal with the Potomac. The incline rises 39 feet, with a gradient of 1 in 12; and barges of 115 tons are transferred from the lower to the upper reach in 8 or 10 minutes. The caisson is 112 feet long, $16\frac{3}{4}$ feet wide, and $7\frac{5}{6}$ feet high. It is carried on three trucks with 12 wheels each, running on four steel rails laid on the incline, and is drawn up by wire cables worked by a turbine. The weight, however, in this case not being adequately distributed, has proved injurious to the road, so the caisson has been relieved of the weight of the water, and the flat-bottomed barges rest on the bottom of the caisson.

These inclines practically substitute a short length of land carriage in place of a waterway, where a connecting water passage between adjacent reaches, at very different levels, would be costly to construct, or lead to a great expenditure of water and time in transit. A very great extension of this system has been proposed in the ship-railway for carrying ships in cradles, drawn by locomotives, across the Isthmus of Tehuantepec, and thus forming a connection between the Atlantic and Pacific Oceans.

Lifts.—The adoption of hydraulic lifts for connecting two reaches of a canal, where the difference of level is considerable, appears to be growing in favour at the present time. The system is comparatively modern; for though a simple lift, with two counterbalancing troughs, lifted and lowered 8-ton barges a vertical distance of 46ft. on the Grand Western Canal many years ago, it was subsequently abandoned; and the first hydraulic lift was erected at Anderton, in 1875, for connecting the River Weaver with the Trent and Mersey Canal. The difference of level is $50\frac{1}{3}$ft.; and the barges are raised or lowered in two wrought-iron troughs, 75ft. by $15\frac{1}{2}$ feet with 5ft. depth of water, each resting on a central hydraulic ram, 3 feet in diameter, working in two hydraulic presses underground, which can be connected at pleasure, making the troughs counterbalance one another. One trough accordingly ascends as the other descends, the motion being imparted by removing 6 inches of water from the lower trough; and only the final lift of about $4\frac{1}{2}$ft., required when the descending trough reaches the water in the lift-pit, has to be effected by hydraulic power. The whole lift is accomplished in $2\frac{1}{2}$ minutes, and one 100-ton barge can be transferred from the river to the canal, and another from the canal to the river in eight minutes, with an expenditure of only 6 inches depth of water over the area of one trough, and the power required for the final lift of $4\frac{1}{2}$ft.

A similar lift, on a somewhat larger scale, has recently been opened at Les Fontinettes,

near St. Omer, on the Neufossé Canal, in place of a flight of five locks, which were inadequate for the traffic. The height of lift is 43 feet; and each trough is $132\frac{3}{4}$ feet by $18\frac{1}{3}$ feet, containing a depth of $6\frac{1}{2}$ feet of water, and weighing 770 tons, and accommodates barges of 300 tons.

On the Canal du Centre, in Belgium, there is a rise of 220 feet in a distance of only five miles; and this is to be surmounted by four hydraulic lifts similar to, but still larger than the two just described. The first of these lifts was commenced at La Louviére in 1885. The height of lift is $50\frac{1}{2}$ feet; and the troughs, $141\frac{1}{2}$ feet by $18\frac{1}{3}$ feet, with a depth of $8\frac{1}{2}$ feet of water, and weighing 1,100 tons each when loaded, are designed to admit barges of 400 tons. The chief motion is imparted by admitting $4\frac{1}{2}$ inches of water into the upper trough; and the water-pressure for the final lift is provided by the aid of two turbines moved by the fall of water from the upper reach. The great advantage of these lifts is that, besides moving easily, they expend very little water, and can accommodate a very much greater amount of traffic than is possible with a flight of locks, owing to the very much shorter time occupied in the operation of lifting.

Classification of Canals.—In considering the question of canals, it is essential to bear in mind the three distinct classes into which canals may be divided. (1.) Ship-canals, like the Suez, Panama, Nicaragua, Isthmus of Corinth, and Baltic canals, which cut across narrow necks of land, and shorten the routes of the sea-going traffic of the world. (2.) Ship-canals, like the Amsterdam, the St. Petersburg and Cronstadt, and the Manchester canals, which enable ocean steamers to reach great commercial centres situated on shallow bays, or at some distance from the sea. (3.) Barge canals, which provide waterways for the internal commerce of a country.

The first class of canals, though of great international and engineering interest, concerns ocean routes, and has no reference to inland navigation, and therefore does not come within the scope of the conference.

The second class of canals is limited in its application to large towns and important commercial districts, at only a moderate distance from the sea, which have a sufficient trade to justify a large outlay on canal works, in order to save transhipment, as at Manchester, or to enable them, as in the case of Amsterdam, to maintain a competition with towns having better natural access to the sea. Comparatively few important towns are not on rivers having capabilities, if improved, of affording a deep-water approach, and yet near enough the sea to offer a prospect that a direct canal connecting them with the sea would be fairly remunerative. Schemes have, indeed, been propounded for enabling sea-going vessels to reach Paris and Brussels; but hitherto, even in this age of engineering enterprises, the large works and cost involved have prevented these schemes from being seriously taken in hand.

The third class of canals, though far less ambitious than the other two, has proved of great advantage in many places in the past, and appears destined to render important services in the future. A comparison of the sections of the Marne-Rhine Canal, one of the typical inland canals of France, of the Erie Canal, and of the Firth and Clyde Canal, with the sections of the Amsterdam and Manchester ship-canals, show how distinct these two classes of canals are.

Requirements for Inland Canals.—It has already been pointed out that, in order to comply with the requirements of traffic, and to maintain a successful competition with railways, it is necessary that inland canals should be of uniform gauge along a through route; that they should be of enlarged section; that increased rapidity and economy in transit should be secured by the adoption of steam haulage; and that saving of water as well as of time should be obtained, where a great difference of level exists between the adjacent reaches, by substituting inclines or lifts, or locks of large lift with improved arrangements, for flights of locks. The sides also of the canal require to be protected, by pitching or dwarf walls, to avoid erosion from the wash produced by steam haulage.

The modified French canals of $6\frac{1}{2}$ feet depth admit barges of 300 tons; and a depth of $8\frac{1}{2}$ feet, on the Canal du Centre of Belgium, allows of the passage of 400-ton barges. The large traffic on the Erie Canal, between Lake Erie and the Hudson River, is conducted in barges of 250 tons; and the canal has a depth of 7 feet, with a bottom width of 56 feet, and pitched side slopes of 1 to 1; and the locks are 110 feet long and 18 feet wide. The Welland and St. Lawrence canals are on a larger scale, as they provide access to the coast for the navigation of the large inland lakes of North America, with vessels of 1,000 to 1,5000 tons, and therefore, like the Ghent-Terneuzen Canal, occupy a sort

of intermediate position between inland canals and ship-canals.

Difference in Traffic on French Waterways.—In France, as in England, all the large tidal rivers have an important traffic up to certain large towns on their banks, as, for instance, the Seine up to Rouen, the Garonne up to Bordeaux, and the Loire up to Nantes. When, however, inland navigation in its strict sense alone is considered, it appears that only certain favourably situated waterways possess a large trade; whilst the traffic on most of the remainder is quite small. Thus, out of a total length of 4,709 miles of navigable rivers in France, only 26 miles possess a traffic exceeding 2,000,000 tons in the year; 135 miles, a traffic of 1,000,000 to 2,000,000 tons; 203 miles, 500,000 to 1,000,000 tons; 827 miles, 100,000 to 500,000 tons; whilst the remaining 3,518 miles have a traffic of less than 100,000 tons a year. Again, out of 2,889 miles of canals in France, only 21 miles possess a traffic exceeeding 2,000,000 tons in the year; 81 miles, between 1,000,000 and 2,000,000 tons; 343 miles, between 500,000 and 1,000,000 tons; 1,432 miles, 100,000 to 500,000 tons; and 1,012 miles, less than 100,000 tons a year. Accordingly, the inland traffic is quite small on three-fourths of the navigable rivers, and one-third of the canals in France; and the very large traffic is confined to small sections in both cases. The main inland traffic is, in fact, concentrated on the Seine and the group of waterways connecting the North sea-ports and Belgium with Paris. A short section of the Seine close to Paris, of the Scheldt near Cambrai, and the St. Quentin Canal, have a traffic exceeding 2,000,000 tons a year; the Oise, near its junction with the Seine, possesses a traffic of 1⅝ million tons; and the St. Denis Canal, a traffic of over 1,000,000 tons. The Marne-Rhine Canal and the Berry Canal have a traffic of somewhat over 500,000 tons a year; but the traffic on the Central, Bourgogne, and Eastern Canals falls below this amount. About two-fifths of the goods conveyed by water in France consist of building materials and minerals; one-quarter of coal and coke; and one-eighth of agricultural produce and provisions. The waterways of France convey about one-sixth of the total merchandise transported; but rather more than a third of the coal supply of Paris is brought by water.

Canal Organisation in France. — The rivers of France are in the hands of the State; and only one-sixth of the total length of canals is out of its control. The State constructs and maintains the canals, and improves the waterways; and since 1880, the navigation has been free of toll, so that the rivers and canals are treated as national highways, all costs being paid out of the general taxes. The objects aimed at, in the improvements and extensions carried out, are the development and completion of the network of waterways throughout the country, without any view to a return from the expenditure beyond the general benefit to the nation of improved means of communication, and the indirect advantages that an increase of commerce brings to the State.

Canal Prospects in England.—It is extremely improbable that Parliament will ever sanction the purchase of the canals in England by the Government, or that, if they did become the property of the State, they would be thrown open for navigation free of toll. Such a proposal would naturally raise a vehement opposition on the part of all the powerful railway interests, and would be of doubtful soundness financially. Moreover, canals are not, like roads, a necessity for the whole community. The improvement of canals in England seems, therefore, destined to depend on private enterprise; though their acquisition and amalgamation might be advantageously facilitated by legislation. Whatever improvement works, accordingly, are undertaken must afford a good prospect of a reasonable return on the capital expended, as shareholders have little interest in the promotion of public benefits at their own expense. It is, however, clear, from the difference in the amount of traffic on French canals, that many of them could not possibly be remunerative undertakings, if they attract so little traffic when freed from tolls; whilst a few might afford very profitable returns. The statistics, in fact, show that great caution must be exercised in the selection of canal routes for improvement, if they are to prove a commercial success, and that the scope for such schemes is strictly limited. Any attempt at a general revival and improvement of the canal system throughout England cannot prove financially successful, as local canals, through thinly-populated agricultural districts, could not compete with railways. Those routes alone should be selected for enlargement of waterway which lead direct from the sea to large and increasing towns, like the proposed canal from the Bristol Channel to Birmingham, or which, like the Aire and Calder Navigation, and the Leeds and Liverpool Canal, are

suitably situated for the conveyance of coal, and general bulky goods, to populous districts.

One or two through routes to London from manufacturing centres, or from coal-mining districts, might have a prospect of success, provided the existing canals along the route could be acquired at a small cost, and the necessary improvement works were not very heavy. If once a scheme like the one for connecting Birmingham with the sea, by a waterway for barges of 300 tons, was carried out with successful results, confidence would be restored in canal extension, and there would probably be little difficulty in raising capital for schemes with similarly hopeful prospects.

Mr. W. H. Wheeler, C.E. (Boston), said thanks were due to Mr. Harcourt for his valuable paper, and to the Society of Arts for bringing the question forward. As a resident in an agricultural district, he thought the subject was one of very great importance as regarded the future of this country. Looking at the depressed condition of agriculture, a very different system must be adopted by us to that followed in the past. Wheat could no longer be grown in this country in competition with foreign wheat carried at cheap rates; and to enable us to compete with foreign farmers, produce of a heavier kind must be grown, and to carry this, canals and steam tramways must be constructed. Railway transport would not do on account of the cost. In his part of the country they had almost as good a system of waterways as existed in Holland, but the traffic had not paid for the expense of keeping the canals up, and they had been allowed to go to ruin. For the sake of drainage purposes, in some cases navigation rights had been bought up. He was speaking of the Fen district, in Lincolnshire and Norfolk, and might quote as an example the little River Nar, which used to be a navigation, but now the navigation rights had been bought up, and barges could no longer get up the river. Seeing the amount of traffic carried on the rivers and canals of Holland, and the quantity of Dutch produce thus enabled to be sent to this country, and sold in our markets in competition with our own farmers, we had every reason for carrying out improvements in our English waterways. He thought the Government should take the matter up, and see whether something could not be done towards developing and restoring our inland navigation by means of the canals.

Mr. J. J. Colman, M.P., echoed what the last speaker had said in reference to the gratitude which the producers and manufacturers of this kingdom would feel to the Society for allowing this subject to be brought forward and discussed at the Conference. The engineering part of the question was most interesting, no doubt, but he would say a few words on the cost of carriage. While at Manchester during the last meeting of the British Association, he heard some striking figures given by a practical man with regard to the cost of carriage by water as compared with that by railway. He was not able at the moment to give the figures, but he was very much startled by them. Speed, of course, was of importance, but speed was not always of so much importance as the question of cost. In the papers announced that question was rather conspicuous by its absence, but the Society would certainly be doing a great service to the country if it should be the means of the subject being brought into public notice.

Mr. E. Packard, jun. (Ipswich), said Mr. Colman had raised a point of great interest. He was himself interested in a five or six mile section of a small canal. For his particular business the whole of the traffic had formerly been carried by railway, and it was now entirely carried by water. From time to time the traffic rates had been raised by the railway company, the works having been originally established through facilities given by it. The rates were raised from 1s. to 1s. 9d. per ton, and it was the last straw which broke the camel's back. That induced them to avail themselves of the canal, which had then become almost disused—perhaps only ten loads a year going along it. They were now carrying along it 1,000 tons a week, and the cost of that traffic was only 1s. 2½d per ton, including 5d. per ton, which had, up to the present time, been paid to the railway company itself, as lessee of the canal. Those figures showed within a little the cost of navigating one of the most inconvenient canals which could possibly be designed, and on which the maximum load that could be carried was extremely small, and moreover, the canal could only be entered at high tide. That was between Ipswich and Bramford, on the Ipswich and Stowmarket Navigation. They commenced by using horses, but they found that the work was so heavy, and so severe upon the animals, that they determined to try steam, and most of the work was now done by a small steam-barges, which towed two or three barges, carrying 25 to 30 tons a-piece.

The Chairman pointed out that one of the papers to be read dealt with the subject of the cost of canal transport.

Mr. T. H. Chance, representing the Gloucester interest, regretted that both in the Chairman's opening remarks and in the paper which had been read a somewhat moderate opinion was expressed inclining towards the inexpediency of the Government undertaking the canals of the country.

The Chairman, on the contrary, desired to be entirely neutral.

Mr. CHANCE said this Conference, which was likely to have an important influence on this question, should not hastily commit itself to any opinion adverse to the possible acquisition of the canals by the Government of the country. In the paper the proposition for carrying the canals in the Midlands to the sea was very favourably spoken of. Unfortunately in his own district it happened that they were not strong enough, or rich enough, to carry out by themselves a work which was essentially necessary for the trade of the district, and which, it was believed, would be of great national advantage. If they were to be deprived of the public assistance which was rather deprecated in the paper, this improvement, immensely desirable as it was, would never in all human probability be made at all. With regard to the promotion of Public Trusts in these matters, he did not know whether it was the design of the Conference to give effect to its views by any expressions of opinion, but if they did so he believed that one of the most immediate results of the Conference would be to strengthen the hands of the Hon. Philip Stanhope, who was endeavouring to get into the Railway Bill some clauses by which corporate bodies might be empowered to give assistance to the extension and improvement of the canals, which, in the district he was referring to, the people were earnestly, but not too hopefully at present, endeavouring to carry out. If it were once admitted that it was desirable that the public funds should be used for this purpose, and that the influence and power of public bodies should be applied to this work, surely that afforded another reason for the Conference keeping an open mind on the question of the Government taking up the matter. If it were desirable for local governing bodies to give their assistance for that object, surely it was only an extension of that principle to admit at any rate the possibility that it was desirable for the Government to do so, especially in cases where the alternatives would be the perpetuation of the present wretched state of things or the accomplishment of a work which would be for the public benefit and for the advantage of the country. The Gloucester and Berkeley Canal, from Gloucester down to the estuary of the Severn was, in comparison with its width, of greater depth, and had a better ship-carrying capacity than any other similar canal in the world.

The CHAIRMAN said the question of passing resolutions rested entirely in the hands of gentlemen attending the Conference. Perhaps Colonel Blackman would say a few words about the Nicaragua Canal.

Colonel BLACKMAN said no doubt canal improvement was one of the most important questions of the present century. He was not prepared to go into the subject as regarded his own canal, and do justice to it without diagrams. With American as with English canals it had been very much the same old story of railway transport being substituted for that by canals, though the former had been so costly to both communities, and had entirely failed to afford a cheap means of transport. It was well established that there was no highway like the highway which God had furnished for the commerce of mankind. It was equally true with regard to American canals, that great improvements and developments of large districts could be made by making canals which could carry all the heavy and slow freights at very reduced rates as compared with the railways, which now ground down the agricultural and commercial interests by their arbitrary charges. There too, as in this country, many of the canal routes had been purchased by the railways, and they felt that it had become a necessity for the agricultural, commercial, and manufacturing industries to keep opened a waterway to the sea-board by the canal systems, to operate as a lever, or balance-wheel, against the excessive charges now levied by the railways. Although he could not give figures with regard to the Erie Canal, it was a fact that that system alone carried more traffic from the West, limited as it was in its extent, than all the railways which centred in New York. A conference was held recently, in New York, with regard to the expenditure to be made on the Erie Canal, and it was determined to expend $4\frac{1}{2}$ millions upon the enlargement and improvement of the locks of the canal. He regretted that he was not prepared to go into the subject of the Nicaragua Canal at present, but if time permitted, before the Conference concluded, he would endeavour to discuss it.

A MEMBER asked whether Colonel Blackman could affirm, as a fact, that the Erie Canal was entirely a State work, and that the proposed expenditure was from the national funds?

Colonel BLACKMAN said it was a State work, and that it was proposed to make it free of toll.

Mr. J. S. WATSON (of Gainsborough) said that in examining the history of canal navigation, it appeared that very little effort had been made to deal with the inland navigations of our great rivers upon any system in accordance with the physical conditions of their basins, or to link them together as economic through routes with reference to the industrial traffic which would come upon them. The canals had been carried out piecemeal in the interests of the proprietors who had promoted them, and sometimes by public authorities or public trusts whose interests were entirely limited to the districts from which they drew their funds, while most of the best of the canals afterwards became merged in the hands of the railways, who would no doubt continue to hold them in suppression of the trade for which the canals were originally constructed, in suppression of cheap inland water transit. Canals which had been constructed out of public funds, and by public trusts, had even been taken over in that way. One might trace this

up the basin of the Trent, when the first attempt at canalisation in this country was attributed to the Romans, in the case of the Fossdyke. That Fossdyke had vested in the Corporation of Lincoln, and gave them a good waterway down to the Trent, to the Yorkshire coal district, and, in the other direction, to Boston; but about 1840 the Corporation leased it to Mr. Elison, a local man, for £75 a year for 999 years. The necessities of drainage subsequently required it to be deepened, which was done largely at the expense of the Land Drainage Commissioners, and the traffic then greatly increased. In 1846 the lessee's executors leased it to the Great Northern Railway Company for £9,575—a considerable advance on £75. Thus the public had lost their hold upon that useful waterway. Again, at Burton-on-Trent, under the Act of 1700, the lord of the manor was empowered to canalise the river from Burton to Shardlow, near Nottingham. The town of Burton was put under contribution for half the expenses, and the navigation was of considerable use to the town. But the undertaker unfortunately leased his undertaking to certain carriers who desired to make a monopoly of it, and prevent other carriers from competing with themselves. Hence when the Grand Trunk Canal was opened to the north of it, and the small cutting connecting it was bought up by the Midland Railway Company, and dried up, the traffic declined, and the navigation is now derelict. At Newark, on the same river, Commissioners were appointed in 1770, with power to borrow £30,000, and to make a branch-cut through the town. They did that work, and made an excellent navigation. The tolls on it repaid the whole of the capital expended, and the Commissioners accumulated a considerable reserve fund, but that public navigation was also leased to a trading company. When endeavouring to get through routes improved, one found that those who controlled one section were very unwilling to deepen their portion, or improve it, unless the rest would join. Some were too poor to do it, and others were unwilling to do it because other people would derive a greater advantage than they would themselves, so difficulties had arisen. His conclusion with regard to improving the condition of inland navigation, at the present time, was, that it was impossible to carry out a complete or economic system by private means. Public companies would only work for the benefit of their own shareholders, as promoters' interests, and the interests of the community at large, were not a sufficient inducement for the canal companies to improve the canals for the public benefit. Some public scheme for improving the canal system, and the navigation of rivers, should be carried out at once.

Mr. SHELFORD asked Mr. Vernon-Harcourt whether he had worked out the figures showing what the tolls on the branch canals would amount to if they were charged with interest and maintenance. The Erie Canal was free. Seeing the obvious difference of opinion as to whether there should be State interference or not in the matter, it would be interesting if that qnestion were dealt with in the reply.

A MEMBER pointed out that in the paper it was stated, in reference to the Aire and Calder Canal, that locks which had been built 215 feet by 22 feet by 9 feet would only carry barges of 167 tons. He thought there must be some mistake about that.

The CHAIRMAN, before Mr. Harcourt replied, moved a vote of thanks to him for his valuable paper.

Mr. VERNON-HARCOURT, in reply, said he had got the tonnage of the barges on the Aire and Calder from Mr. Bartholomew's evidence in the Blue-book on canals. The tonnage given seemed to be small for the dimensions of the locks, but he did not like to alter it without further authority. Far bigger barges were of course carried on the French canals. Then with regard to the question of Government purchase. Individually, he was not in the least against Government purchase of the canals if it could be carried out; but though at one time he thought that would be the best arrangement, yet in the Canal Committee, before which he had given evidence, it seemed to him that the general feeling of the members of the committee was so averse to the purchase of the canals by the State, that it was hopeless to further consider the question. The State was the only body which could purchase and improve property for the general profit and benefit of the nation. Though the Government might be satisfied with gaining indirect profit from the increased prosperity of the nation at large, it was of course impossible for shareholders in companies to be so, because they could only maintain and improve their canals with a view to getting direct profits from them. But he felt, from his experience at the committee, that it was hopeless to expect, under present conditions, the purchase of canals by the State. Some canals would pay, while others would not pay; and if the Government were to take them over, they could not expect to make a profit out of all, or even most of them. If it was to be done by private enterprise, of course those which would pay a good percentage would be looked after in preference to those which would pay nothing at all, or very little. He certainly approved of the view which had been expressed that public trusts might be formed. The great difficulty in dealing with canal interests was that it could not be expected that a through route could be improved and worked properly unless it was under the control of one body; and therefore for every through route it was essential that that should be arranged. That would be the direction in which the Legislature might help them. There should be a public trust constituted for each through route; and they should endeavour to carry out systematic improvements throughout each of the principal canal systems. Where two or three bodies were concerned,

it was impossible to expect the necessary improvements to be made in the public interest as they should be. Reference had been made to the small amount of traffic carried on the canals of England, and to the small accommodation they afforded barges. It must strike everyone as a singular fact that when a small kingdom like Belgium was found improving its canals, we should not have done something in the same direction. Not only only along the level portions of Belgium, but also on the Canal du Centre, where there was a rise of over 200 feet in five miles, they proposed to carry 400-ton barges. In that small kingdom they were really improving on the French waterways, and would be able to carry larger barges than were carried on the canals in France. As to the question asked with regard to tolls, he had, at the time the Canal Committee were sitting, inquired about that matter of one of the engineers who had charge of one of the sections of the Seine, and the engineer said that the matter had never been investigated by the French Government. The engineer's letter to him would be found in an appendix to the evidence given before the Canal Committee on p. 254; and it was a notable fact that the French Government were actually trying to buy back the canals which had been leased, with the object of abolishing the tolls upon them, though these were very profitable to the present shareholders. They did not apparently care very much whether a particular canal paid or not; those that did pay helped to pay for those which did not, and the canal system, being for the benefit of the nation at large, they were therefore anxious to improve it as much as possible.

Mr. Hicks, as a member of the Canal Committee, wished to say a few words with reference to the remark made by Mr. Vernon-Harcourt as to the Government purchase of canals. He fully concurred in the undesirability of the Conference pledging themselves to any opinion upon that subject, and his own mind was certainly entirely open in the matter. But Mr. Harcourt appeared to be under the impression that there was a general agreement of opinion among the members of the Committee adverse to that proposal. He wished to say that, having been upon that Committee, and very seldom absent from its meetings, he did not remember that the subject ever had been brought forward among them. Questions giving some such indication might have been asked among individual members, but the subject had not come forward in a substantive form, either in the general body of the Committee or in the section where he was working.

Mr. Hyde Clarke writes:—The discussion on Mr. Harcourt's paper having closed, I beg to offer a few remarks in writing. It appears exceedingly desirable not to shut out the possibility of a purchase of canals by the State at some future time. The necessity for this is shown by the argument brought forward that the railway companies would combine against such purchase and prove too strong. If the railways themselves are acquired by the State, as the necessities of the country in competition require, then no resistance from railways would intervene. Those who have brought forward the relations of canals as public highways do not adhere to the consequences of the doctrine, that as highways the canals, as well as the railways, are creatures of the prerogative of the State, and are always subject to its jurisdiction and administration. It has never been a question whether a common road returned an income, or a profit or not, but what were or are its purposes of public utility. Such is the ultimate consideration which must govern canals, and which will be influenced by the competition to which our population and commerce are exposed by the State railways or canals of Germany, of Holland, of Belgium, of France, and of Switzerland. It will not be a question of what we may hope to do of our own will, but what we are compelled to do by others. With regard to acquisition by the State, no financial difficulty arises, and no real administrative difficulties. Railway companies, tenants of the prerogative of the State, do not represent private enterprise, but the interests of effective monopolists. As to incidental difficulties of Government administration they are not worse than those of the companies, but some difficulties are accidental. The defects of postal and telegraph administration are chiefly due to the interference of the Lords and clerks of the Treasury, and the appropriation of the surplus of the Department to the Budget, so that the Post-office is impeded or starved out. On any requisition of railways or canals by the State, they should be removed from the interference of the general Government, and the Post-office should also be liberated by the surplus tax payable to the Treasury being fixed at the present sum, and all future surplus being at the disposal of the Department. With regard to the fear of the patronage and corruption in the hands of the Government from railways and canals, it is left out of consideration that the general managers of the railways, by means of their railways and canals, are the greatest borough mongers in the country, and that it is by them that railway directors, politically interested, are pitchforked into seats in Parliament in such large numbers.

HISTORY, RISE, AND PROGRESS OF CANAL AND RIVER NAVIGATION IN GREAT BRITAIN AND IRELAND.

By M. B. Cotsworth.

We have not much information respecting the early history of river navigation in the United Kingdom. Its origin is unknown, as it dates back to pre-historic times. Evidence of this exists in the old boats found at Brigg, York, Wakefield, &c , which are

proved to date back to the time of the ancient Britons. Any attempt to trace the period of its commencement must be futile, since it began before man was sufficiently advanced to keep records—probably during the period of the "River Drift Men" in geological times. For present purposes we do not need to make further inquiry, but will take it on the evidence of the early historians that it existed in the earliest times.

Our great rivers, the Thames, Severn, Trent, Ouse, &c., were the recognised means of transit long before the time of the Romans, who were so far advanced in inland navigation as to cut canals of forty miles in length, as instanced in the Caerdyke between Peterborough and Lincoln (though now filled up), as also to build docks, as shown in the old dock walls, &c., still standing at the outfall of the Trym into the Avon below Bristol.

The Fossdyke navigation from Lincoln to the Trent is also of Roman origin, and probably an extension of the Caerdyke on their route to York. Torksey, at the junction with the Trent, was a Roman town and fort, and continued possessed of many privileges, down to the Norman period, on condition that the knights who held it should carry the King's Ambassadors, as often as they came that way, down the Trent in their own barges, and conduct them to York. This is recorded in "Domesday Book." Itchin Dyke to Winchester was also cut by the Romans.

It seems strange that from the time of the Romans until the beginning of the 15th century, no record of attempts to improve the channels of the great rivers is to be found.* They were left to take their natural course. Two reasons may be assigned for this :—(1) The great rivers extended far inland with easy gradients, and were, though a rough and ready, still a practicable means of transit, and sufficed for the limited commerce of that time; (2) the country was so much disturbed by civil wars, that time and effort could not be directed to these improvements.

In 1423, the first Act of Parliament relating to inland navigation was passed, by which the navigation of the Thames was placed under the control of Commissioners and the London Corporation, who commenced a few minor improvements. Then followed the Act of 1425, placing the River Lea under the same authority. Another Act in 1430 extended this authority.

Next in order follows the Charter of 1462, which constituted the Lord Mayor and Aldermen of York conservators of the River Ouse, as well as the Rivers Aire, Derwent, Dunn, Humber, &c., connected with it.

In 1503, the Severn was placed under the authority of Commissioners chiefly representing the Worcester and Gloucester Corporations. The Act of 1514, placed the Canterbury or Stour navigation under the care of Canterbury.

In 1531 and 1535, powers were given by Acts of Parliament to abolish the "Fish-garths," "piles," stakes," "hecks," and "other engines" set in the Rivers Thames, Severn, Ouse, and Humber, which had seriously impeded navigation before. Charges for "hauling" on the "paths" of the Thames and Severn were also authorised.

Thus far we have no trace of works being erected or cuttings made to improve the waterways. The obstructions, shallows, &c., which must have seriously impeded navigation, might have been slightly removed, but we have no evidence of engineering works being carried out since the Roman era, until 1539, when an Act was granted for the Corporation of Exeter to cut a canal over three miles in length, from Exeter to the sea, running parallel with the river. This, the first English-made canal, was very imperfectly constructed, and left open to the ebb and flow of the tide, which damaged the banks, &c., so that another "cut" had to be made lower down a few years later.

Since locks were invented by the Italians 50 years previously (*i.e.*, in 1481, on the Brenta, near Padua), and were not used here, where they would have been of great service, it is fair to suppose that their use was not generally known in England.

As I cannot trace the first introduction of locks into England, I may here remark that before the introduction of locks, "inclined planes," with rollers, were used to transfer boats from one level to the other; the goods being carried up the incline by men and pack-horses.

Proper canalisation was prevented, and traffic greatly impeded by the large number of water-mills erected on the rivers, the owners of which, together with the landowners (who were deeply interested in the fisheries) bitterly opposed the erection of locks, even so late as 1759, when by their opposition (arising from fear of losing their water and fishing rights) they secured the the insertion of clauses in

* Mr. S. Lloyd contested this statement in discussion, holding the Fossdyke (Lincoln) was cut by Henry I., A.D. 1134, but the evidence of Priestley, page 295, and others, disproves it. No doubt, Bishop Atwater's cleansing of this canal has been mistaken by some for its construction.

Stroudwater Navigation Act prohibiting the use of locks. The proprietors endeavoured to work the navigation by shifting the cargoes into boxes, and at each mill raising them to a boat in the other level by cranes; the plan, however, proved a failure, though it was persevered in until the projectors were almost ruined.

Previous to the year 1626, although sixteen Acts had been passed to further inland navigation, and slight improvements had been effected, still England had not produced a practical engineer. During this year, Charles I., who was unable to find an Englishman suited for the work, contracted with Vermuyden, a Dutchman, to reclaim the district round the Wash, which had been flooded by the storm of 1607 bursting the embankments erected by the Dutch settlers. This done, Vermuyden reclaimed the district between the Ouse and Trent, cutting the Dutch River, which falls into the Ouse at Goole, and which proved valuable as a navigation. He then began the drainage of the great "Bedford Level," making many useful cuts and navigable drains, with sluices to pass boats at a certain height of the tide. Vermuyden's useful work was stopped by the opposition of Cromwell, and the turmoil of the civil war which followed.

From 1626 to 1755 the partial and progressive canalisation of the rivers was continued. No less than 81 local Acts of Parliament were granted, most of which referred to the larger rivers, and one of which was the Duke of Bridgewater's first Act of 1737, which was not carried out. During this period the Thames was improved to Cricklade by locks.

In the year 1755 we find canal development begun in earnest. The Sankey Canal Act was obtained and carried out, eight locks being erected.

In 1758, the Calder and Hebble Act was obtained and carried out, locks being used, but the flood of 1767 destroyed them, proving that Mr. Smeaton's "lockwork" was not strong enough.

We next come to the Duke of Bridgewater's Act of 1759, for the canal so grandly carried out by the great Brindley. It is well known that the Duke of Bridgewater's object was to open up his valuable collieries at Worsley, and supply the town of Manchester with coal; yet we cannot think too highly of the public spirit he displayed in carrying it out so effectively, despite the great natural difficulties to be overcome. His penetration is justly praised for having called forth the hidden talents of a Brindley, which otherwise might have been lost to the nation. No doubt the knowledge the Duke had acquired of the canals of Languedoc and Italy, with their usefulness, had greatly influenced him during his early travels.

Time does not admit of more than a very brief description of this canal, though it might well serve for one paper alone. Tunnels and aqueducts were here largely introduced for the first time in England. Priestly, the able canal historian, states that in 1830 there was said to be 18 miles of underground canals and tunnels at Worsley. The splendid aqueduct over the Mersey and Irwell navigation, at Barton, which was opened 17th July, 1761, still stands to-day, the best monument to the genius and perseverance of Brindley, the "Father of British canals."

In 1762, the enterprising and patriotic Duke applied, upon Brindley's suggestion, for powers to extend his navigation to the Mersey, at Hempstones, and so open up a better channel of communication between the Manchester district and Liverpool. But before this latter portion was completed, the first Trent and Mersey Act was passed, in 1766. With a true public spirit, the Duke agreed with the projectors of this scheme to form a junction with their proposed canal at Preston Brook, and carry out the work for them. from that place to Runcorn, where the Mersey is reached. This portion really became the Duke's property, and he took the toll upon it.

Up to this time the four great ports of London, Liverpool, Bristol, and Hull, though well served by rivers for a considerable distance inland, had no channel of communication with each other, except a tedious, circuitous, and uncertain navigation, by coasting craft, which, being dependent upon the wind, were weather-bound, at times, for two or three months together; or the tiresome and expensive land-carriage, which had chiefly to be done by pack-horses, as the roads (which hardly existed) were only fit for waggons during a few months of the year.

To the insular position of Great Britain, and its numerous large and navigable rivers, together with the disturbed state of the country by civil and foreign wars, we may reasonably attribute the long neglect of canal navigation.

The great cost of inland conveyance, coupled with the known advantages of canals, as proved in Italy, France, and Holland, as well as the tempting profits held out thereby to the owners of mineral deposits, agriculturalists, and manufacturers requiring transit in large quantities, brought forth canal projects. At

this time, the cost of goods by road, between Manchester and Liverpool, was 40s. per ton; whilst, by the Mersey and Irwell route, the water-rate was 12s. per ton. After the opening of the Duke's canal, the cost was reduced to 6s. per ton, and a better service was given than either of the previous routes had afforded.

The cost of carriage on coal by pack-horse from Worsley to Manchester, which had been 6s. to 8s. per ton, was reduced to 2s. 6d. per ton on the canal. In fact, the Duke bound himself not to exceed that freight. This was greatly to his credit, especially when we consider the freight he might have secured, seeing that the Old Mersey and Irwell Company still held to their toll of 3s. 4d. for all the coal the Duke sent by their route.

The costs of transport throughout the country were on the same scale, except where held in check by the river traders, who, whilst competing, still had an interest in high freights. From Manchester to Nottingham, the charge was over £6 per ton; to Leicester, over £8, and so on. These were reduced to Nottingham £2; Leicester, £2 6s. 8d., after the opening of the Trent and Mersey Canal, which also reduced the cost between Manchester and Hull to less than £2 per ton, owing to the back-carriage secured from that port, together with the tide service of 80 miles up the Humber and Trent.

The real commercial prosperity of England dates from this period of canal development and enterprise. Raw materials, manufactures, and produce, were easily transported at a reasonable cost between Liverpool, Manchester, Staffordshire, Nottingham, and places on the route to Hull and Northern Europe. These advantages were extended to the Severn route by the Staffordshire and Worcestershire Canal Act, which was obtained during the same year (1766), as also the navigation of the Soar to Leicester.

It is remarkable that no attempt was made to unite the Thames with the Severn until the Act of 1783. This delay was partly owing to the better service given by land carriage for the London trade, as also to the opposition which the road carriers created by their influence in London to canals, assisted by the vested interests of the millowners.

After the canals uniting the four great rivers had been cut, trade increased by leaps and bounds, affording a striking proof of the statement made by General Sir Arthur Cotton (the eminent engineer of the Indian canals) before the Canal Committee of 1883, that "perhaps the first thing after law and order for the promotion of the material prosperity of a country is exceedingly cheap internal transit." These "through canals," profiting by the increased trade which they promoted, were very prosperous, and turned the attention of the nobility, agriculturalists, and merchants to the extension of the canal system, especially as, in addition to its utility, it offered a lucrative opening for the employment of capital, the expenditure of which, by greatly increasing the circulation of money, and opening up more sources of trade and wealth to the community, added still more to the general prosperity.

These extensions included the Birmingham Canal, of 1768; the Oxford Canal, of 1769; the Leeds and Liverpool Canal, of 1770; Ellesmere and Chester Canal, of 1772; Aire and Calder Canal, of 1774, with the Huddersfield Canal and Sir John Ramsden's Canal of the same year. Then the Erewash Canal, of 1777, which together with numerous short lengths opened after 1770, bring us to the Thames and Severn Act of 1783, already alluded to. This important canal was first projected by Brindley, and formed the concluding link in his scheme for uniting the Thames, Severn, Trent, and Mersey by canals. He did not live to see his designs executed (having died in 1772), but after his death, Mr. Whitworth, who was appointed his successor, completed the work.

No doubt the extraordinary amount of work and mental strain served to shorten the life of the great canal engineer. When we consider that the following canals were laid out and principally executed by Brindley, between 1758 and 1772, without plans or the experience of others to aid him, we may well marvel at his genius, enterprise, and perseverance. Certainly his life and labour were employed to the advantage of his fellow-men, and his name will be handed down to posterity with respect as one of the most useful men of the last century.

BRINDLEY'S CANALS.

	ft.	in.	Miles.
The Duke's Canals:—			
Worsley to Manchester	14	2	$10\frac{1}{4}$
Longford Bridge to Runcorn	14	2	24
Trent and Mersey Canal	7	0	89
Stafford and Worcester Canal	7	0	$46\frac{1}{2}$
Coventry Canal	7	0	37
Birmingham Canal	7	0	$24\frac{1}{4}$
Droitwich Canal (his best work)	14	0	$5\frac{1}{2}$
Oxford Canal	7	0	$82\frac{1}{2}$
Chesterfield Canal	7	0	46
			365

	ft.	in.	Miles
Brought forward			365
Add Leeds and Liverpool Canal laid out	15	2	127
Thames and Severn	7	0	31
Total			523

I cannot understand why Brindley, with his practical knowledge, fell into the error of making two gauges in his canals—about one-third are broad, and the remaining two-thirds narrow gauge. It may have been that narrow boats were preferred on account of their extra speed, or were thought sufficient for the then existing trade; or it may have been a question of the price of land and extra cost of construction. In any case, it has proved a drawback to canals in competing with railways.*

To return to our history. From 1783 to 1790 several Acts were passed, the principal of which were the Shropshire Canal Act of 1788, and Cromford Canal Act of 1789, the others chiefly relating to improvement of existing canals and rivers, or respecting additional capital required, as in nearly all cases the costs considerably exceeded the estimates.

With the year 1790 began the canal mania, which resulted in the formation of a very large number of canals, especially in the Midland district. Some of them, such as the Worcester and Birmingham, 1791; Gloucester and Berkeley, 1793; Grand Junction, 1793; Grantham, 1793; Leicester and Northampton Union, 1793; Stainforth and Keadby, 1793; Warwick and Birmingham, 1793; Ashby, 1794; Kennet and Avon, 1794; Peak Forest, 1794; Rochdale, 1794; Warwick and Napton, 1794; Wilts and Berks, 1795, &c., were very useful links of navigation, and proved very remunerative, whilst many short lengths and ill-considered schemes proved little more than failures.

The mania, which extended to 1796, was created by speculations in canal shares, to promote which, many new canals were projected, and incredible sums subscribed. England was in a ferment, as proved by the premiums paid in 1792 on single shares in canals authorised:—Birmingham and Fazeley, £1,170; Stourbridge, £350; Melton, £55; Trent and Mersey, £350; Coventry, £350; Leicester, £155, &c. This mania, whilst it hastened forward canals generally, had the drawback of forcing on premature schemes which would have been executed to greater advantage in steadier times.

* Mr. Taunton's explanation hardly holds good, seeing Brindley's second canal, the Trent and Mersey, was made seven feet wide, although it united the Bridgwater Canal, 14 ft. 2 in., with the Trent, 14 ft. 6 in. wide.

In 1797, a steamboat was tried on the Sankey Brook Canal with success; still, strange to say, manual haulage continued until 1831.

From 1797 to 1800, steady progress was made in inland navigation, so that by the close of the century 1,900 miles of canals had been completed. In Scotland, the Crinan Canal, 1793, and Aberdeenshire Canal, 1796, were progressing, whilst in Ireland the Grand Canal was finished, and the Royal Canal nearing completion.

From 1800 to 1815, continual and steady progress was made. Amongst the numerous Acts the following may be noted:—Caledonian Canal, 1803 (60½ miles—cost £977,524); Glasgow, Paisley, and Johnstone Canal, 1806; Tees Navigation, 1808; Grand Union Canal, 1810, completing the London route to Leicester, Nottingham, and the Erewash Coal-field, as well as through route to Staffordshire, Liverpool, and Manchester, by the Trent and Mersey, and by the Trent to Hull and Yorkshire.

In the year 1812, the Regent's Canal Act was passed, and the Sheffield Canal Act in 1815.

In this year Macadam introduced his system of repairing roads, which led to an increase of competition between the road carriers and canals, but as the result was the creation of increased trade throughout the country, the canals were rather benefited than otherwise.

The Peace of 1815 succeeding, the nation speedily recovered from the brief period of depression caused by the War, and immense progress was made in home industries. Trade and manufactures flourished, whilst shipping extended, and a full tide of commerce poured into England from every quarter of the world. Inland navigation improvements were still the order of the day, and many additional Acts were passed extending the powers of the established companies, whilst the following were the principal new ones authorised:—Edinboro' and Glasgow Union Canal, 1817 (30 miles); Birmingham and Liverpool Junction Canal, 1826; also the Macclesfield Canal the same year.

In the year 1830, the Ellesmere and Chester Canal Company obtained further powers to improve their navigation, construct a reservoir, and in addition, to provide boats, &c., and become carriers. This, I believe, is the first instance of a canal company obtaining carrying powers.

In 1832, the Act authorising the Ulster Canal in Ireland was passed, which practically brings the period of canal construction to a close. The canal and river navigations, the system of which was considered complete, consisted of the following:—

	Rivers.		Canals.
England ..	1,142 miles	..	2,323 miles.
Wales	,,	..	128 ,,
Scotland ..	,,	..	212 ,,
Ireland	,,	..	256 ,,
	Total........		2,919 ,,

Of these 2,919 miles of canal, about 536 had been made since 1800.

Inland navigation had now reached the height of its prosperity. The dividends paid by the principal companies were high, and appeared likely to increase. The following prices of canal shares, with the dividends, are worth notice at this time—1833:—

Name of Company.	Amount of Share.	Market Value of Share.	Dividend.
	£	£	£
Aire and Calder ....(very	high, but	being priv	ate, unknown)
Bridgewater Navigation	,, ,,	,,	,,
Loughbro' Navigation...	142	1,820*	124
Erewash Canal	100	705	47†
Mersey and Irwell	100	750	40‡
Trent and Mersey.........	50	640	37½ or 75 p.c.
Oxford Canal..............	100	595	32
Coventry Canal...	100	600	32
Forth and Clyde Canal	100	545	25

These canals, by continuing to charge the heavy tolls necessary to maintain these exorbitant dividends, materially assisted the introduction of their great rivals—the railways—as strikingly shown in the origin of the Midland Railway.

The Derbyshire and Nottingham colliery proprietors had exclusively supplied Leicester with coal, until the opening of the Swannington line, in 1832, placed the trade in the hands of the North Leicestershire Colliery people. A reduction of 3s. 6d. per ton on coal delivered at Leicester, from the Erewash-valley, was needed to enable the Derbyshire and Nottinghamshire proprietors to retain the trade. As this traffic amounted to 160,000 tons a year, it was a great question, both for canals and colliery proprietors. The question was whether coal-owners or canal proprietors should make the sacrifice. The Erewash Canal received, for toll and wharfage, 2s. per ton for 12 miles; Loughbro', 3s. per ton for 8 miles; Leicester, 1s. 8d. for 14 miles—total, 6s. 8d. per ton (exclusive of boating and haulage charges), for 34 miles, or 2⅓d. per ton per mile. Conferences were held with the Canal Committees, who decided to each allow a drawback of 6d. per ton (1s. 6d. in all) "on such coal only as shall be delivered at Leicester at 10s. per ton." The coal-owners who held that the canals should each allow 1s., "promptly rejected" these proposals, and the meeting broke up, with the colliery proprietors determined to free themselves from the monopoly of these canals by making a railway. This foolish over-reaching of the canals was a great tactical error, and placed the railway before the public as a deliverer from canal monopoly. The result was, the railway secured the traffic to the detriment of the canals, who are now, in 1888, glad to pass coal at 2d. per ton each, or 6d. per ton for the whole 34 miles.

Railway development was rapid during the following years, and offered an increasing competition to canals, who were gradually beaten, so that in 1842 the average canal dividend was only 7 per cent. (Still this was more than the railways paid). The canal companies generally failing to keep pace with the times, were gradually overcome. Then followed the railway mania of 1846 and 1847, when many of the leading canals were transferred to railway control. This strangled the others, as effective restrictions were enforced to divert through traffic to railways. Since that time the positions of canals generally has gradually become weaker, whilst the railways, largely owing to the enormous increase of passenger traffic, and engineering improvements, have become more firmly established.

Still it is cheering to note that those canals which have kept abreast of the times by improvements in carrying capacity and management, have more than held their own against railways, as instanced in the Aire and Calder Navigation, the Leeds and Liverpool Canal, paying 23½ per cent., the Bridgewater Navigation, and others. From this we may gather, that canals are beaten where the old systems of working still exist, but that when improved to meet the requirements of present trade, and well managed, they will again become, both useful to the community, and remunerative to the proprietors.

* Have been sold for £4,500 each, and dividend 306½ (now price £120 each).

† Dividend, in 1842, £62.

‡ Dividend, in 1842, £25.

THE HISTORY OF THE RISE AND PROGRESS OF WATERWAYS AND RAILWAYS IN ENGLAND AND WALES, AND THEIR MUTUAL INFLUENCE ON EACH OTHER.

By Urquhart A. Forbes.

"Of all inventions," says Macaulay, "the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for civilisation." * With our present elaborate and extensive system of internal communications, it is by no means easy to estimate the magnitude of the debt which British civilisation owes to such inventions. It seems, for instance, almost incredible now-a-days, that "in the seventeenth century the inhabitants of London were," as Macaulay tells us, "for almost every practical purpose, further from Reading than they are now from Edinburgh, and further from Edinburgh than they now are from Vienna." †

Still more incredible, perhaps, will seem to many the fact, recorded by a late writer, that the rapid progress made by this country, as compared with other nations, in the development of her manufactures during the 18th century, was very largely due "to the facilities for water-carriage afforded by her rivers, for all communication by land was still in the most neglected condition."‡ Our highways by road, by water, and by rail, have now indeed become a necessary part of our existence, and we seldom trouble ourselves to think about them save when they affect our pockets, with regard to the payment of rates or the sale and purchase of shares. The present Conference, however, is a proof that the contest that has been waged during the last few years between the producers of the national wealth, as represented by the manufacturing, agricultural, and trading classes, and the railway companies, which, practically speaking, now enjoy the monopoly of distributing it, has begun to awaken the nation to the fact that the internal communications of a country are matters of national importance which essentially affect its well-being. It may therefore, perhaps, be useful to endeavour to ascertain what aids towards the solution of the difficult problem of their development and control are furnished by the history of the growth of our waterways and railways.

* "History of England."

† *Ibid.*

‡ "The Industrial Revolution in England," by the late Arnold Toynbee, p. 51, 52. (1884.)

If we may rely on tradition, the first waterways constructed in England were the work of Henry I., who, in 1121, converted into navigations the old Roman cuts in Lincolnshire, known as the Caer Dyke and Fosse Dyke, the former of which extended 40 miles from Peterborough to the Witham, and the latter 11 miles from the Witham to the Trent. It is also said that the large drains in the Fen districts, cut by the churchmen who established themselves there in early times, were used for the purposes of navigation. The most trustworthy evidence, however, of the antiquity of highways by water in this country is to be found in the statutes of the realm.

The numerous Acts of Parliament, amounting probably to over 1,000, under which our waterways have been constructed and managed, may be divided into three classes, each of which represents a distinct era in the progress of inland navigation. The first class comprises Acts for preserving, restoring or improving the navigation of rivers formerly navigable, the second those for making navigable rivers originally non-navigable, and the third those for providing for the construction of canals or artificial waterways over lands purchased for the purpose. All these three kinds of waterways are subject to the paramount public right of navigation, but the extent of its exercise varies on each, the public having rights over a river navigable from time immemorial which cannot be claimed against the conservators of a river made navigable by Act of Parliament, while the use of canals—which, though constructed solely for the benefit of the public, are the private property of their constructors—is still more strictly limited. Each of the three varieties is, however, subject to the same general provisions as to the preservation of the navigation, the regulation of traffic, and police supervision.

The duty of the conservancy of navigation was, in early days, according to Sir Mathew Hale, entrusted to the Crown, as representative of the State, but was, in course of time, delegated to various subordinate authorities, the most important of which were the Commissioners of Sewers, established by the famous Bill of Sewers (23 Henry VIII., c. 5). From them it gradually pased to various conservancy authorities, created by special Acts. Early documents show that the Legislature, in those days, considered the navigation as paramount to every other right in the great rivers, and that while obstruction was continually reassert-itself, it had to be as constantly dealt with by

law. The Charter of Richard I., granting the Thames below Staines to the City of London, Magna Charta, the 23 Ed. III., stat. 3, c. 4, and numerous other Acts, are evidence of this, and show also that, down to the end of the 15th century, the statutes regulating navigation applied generally to all the great rivers of the kingdom.* As early as 1394, the Conservancy of the Thames was entrusted to the Mayor and Corporation of London: and in 1431, we find the Chancellor of England empowered by Henry VI., c. 9, to grant his commission to certain persons to "scour and amend the River Ley, in the counties of Essex, Hertford, and Middlesex." In the reign of James I., some two centuries later, we still find several Acts passed for improving the navigation of rivers, and it is not apparently until after the Restoration that any measure for making non-navigable rivers navigable received the sanction of the Legislature. Some years prior to this, however, there seem to have been various schemes broached for following the example of the Dutch, in turning their waterways to account. Such, for example, were a project for rendering the Avon navigable from the Severn, near Tewkesbury, through Gloucestershire, Worcestershire, and Warwickshire, which had to be abandoned on the outbreak of the Civil War; an "appeal to Cromwell and his Parliament, on the immense advantage of opening up a water-communication between London and Bristol," by Francis Mathew, published in London, in 1656; and a work by Andrew Yarranton, published in 1677, pointing out what the Dutch had accomplished in the way of inland navigation, and what England ought to do in the same direction, in order to compete with her great trading rival.

One of the first acts for making non-navigable rivers navigable appears to have been that passed in 1676, for making the Avon navigable from Christchurch to "the city of New Sarum" (16 & 17 Car. II. c. 12); and in the same year were passed Acts for making navigable "the river and sewer from or near Bristowe Causey, in the county of Surrey, to the River Thames" and "the River Medway;" and one "for making divers rivers navigable or otherwise passable for boats, barges, and other vessels." The channels of several of our largest rivers appear to have been dredged and cleared out —apparently, however, in a very imperfect manner—during the period between the passing of the above Acts and the commencement, in 1759, of the Duke of Bridgewater's Canal, which opened the era of artificial navigation. Two of the latest of such Acts appear to have been that for connecting Worsley Brook with the Irwell, near Manchester, in 1737, and that for making the Sankey Brook navigable, from the Mersey to St. Helens, in 1755.

* See the Report of the Select Committee on Thames Preservation, 1884, pp, iv., v.

Up to the period we have reached, waterways were under the control of the State, or of authorities appointed by the State for the conservancy of navigation, and that the arrangement was, on the whole, not without its advantages, is evidenced by the fact already referred to that in the middle of the eighteenth century (1760), the advantages with regard to water carriage enjoyed by England enabled her to outstrip other countries in the development of her manufactures. With the construction of the first canal began the era of private enterprise in respect of inland navigation, which owes its existence, as it is hardly necessary to remark here, to the genius of Brindley, and the unflagging determination of the Duke of Bridgewater, whose efforts in the cause of progress were, like those of Stephenson, and the pioneers of railway enterprise after them, at first strenuously opposed by the public, and entirely neglected by the State.

The turning point of public opinion, both as regards canals and railways, was the discovery that money might be made out of them. Brindley's grand project of uniting the four great ports of Liverpool, Hull, Bristol, and London by a system of main waterways from which subsidiary branches might be carried to the contiguous towns, had been, to a large extent, successfully accomplished at the end of the first quarter of the present century, and when canals began to pay dividends, the nation began to admit their public utility. In a very few years after Brindley's death in 1772, an immense number of navigation Acts received the sanction of Parliament, canals began to be freely quoted "on 'Change," and, in 1790, what Mr. Lloyd has aptly named "the canal mania" began.* The *Gazette* of August, 1792, contained notices of eighteen new canals, and the premiums of single shares in companies had reached such figures as £155 (Leicester), £350 (Grand Trunk and Coventry), and £1,170 (Birmingham). Canals began to be used for passenger traffic, and we read in the *Times*, of 19th December, 1806, of troops being despatched

* See a paper read before the British Association at Birmingham, 1887.

from London to Liverpool by the Paddington Canal *en route* for Ireland, a mode of transport which the writer points out would enable them to reach Liverpool "in only seven days!" In the four years ending 1794, no less than 81 canal and navigation Acts were obtained, of which 45 were passed in the latter two years, authorising an expenditure of over £5,000,000. No less than £1,200,000 was spent upon the construction of the 130 miles of waterway connecting Liverpool, by way of Skipton, with the Aire and Calder at Leeds, a work begun in 1770, and not completed till 41 years afterwards, and when the last canals in England were completed in 1830, the total amount that had been expended upon our waterways was about £14,000,000. Out of some 210 rivers in England and Wales, 44 in England have hitherto been made navigable.* The Thames, the Severn, and the Mersey are connected by 648 miles of river and canal, the Thames and Humber by 537 miles, the Severn and Mersey by 832 miles, and the Mersey and Humber by 680 miles; the Fen waters have an extent of 431 miles, and the remaining canals of England and Wales amount to 1,204 miles.† This fine system of waterways, with a total length of 4,332 miles, furnishes no less than 21 through routes for traffic between London and the manufacturing districts,‡ but, as it is scarcely necessary to observe, a very large portion of it has ceased to be of any practical value, while the utility of that which is still available to the public is constantly diminishing, through the neglect due to the impoverished condition of the canal companies. These results are very largely due to the disastrous influence which the development of railway enterprise has had upon our system of inland navigation.

The opening of the Stockton and Darlington line on the 27th September, 1825, may be said to be the birthday of the railway system.§ In the five years that followed, which were marked by great commercial depression, many lines were unsuccessfully attempted. The opening, however, of the Liverpool and Manchester line, in 1830, seems to have brought home to the public mind the revolution in travelling that was imminent, and the success of the railway system may be said to have been finally assured when, after a great struggle with the landowners and others opposed to the movement, the line from London to Birmingham was opened in 1838. Some 299 Acts, authorising the construction of 3,000 miles of railway, had been passed by the end of 1840, but the Blue-book known as the "Five Reports on Railway Communication," which was issued that year, and dealt with all the questions involved in the subject it examined, shows that the true nature and capacity of the system was by no means yet thoroughly understood. Railways appear to have been regarded as a species of "land canals," the right of way over which was left open to all, with the full consent of the promoters, who at first declared that it was not their wish, and that it would be against their interest, to attempt the carriage of passengers or goods, and that they were only desirous of being toll proprietors. Hence we find the Legislature enacting that any person might run his trains over the lines by paying certain tolls, that owners and occupiers of adjoining lands might make branch lines and have free access to the railway, and that lords of manors and others might erect wharves, and use such portions of the railway as passed through their lands free of all charge. The obvious objections to this plan naturally soon led to its modification; but even so late as 1840, although in some cases—as on the Manchester and Liverpool line—companies were required by their Acts to undertake the carriage of all goods, in others private carriers frequently competed with them, as on the Grand Junction and Great Western; while in others again they were the sole carriers, as on the line from London to Birmingham, on which the company merely provided the trucks and engines. These and other defects characterising the first

* See the House of Lords Committee on Conservancy Boards, 1877, *passim*.

† See Report of the Select Committee on Canals, App. 210.

(‡) Report of the Select Committee on Canals, pp. 210.

(§) The earliest approximation to modern railways appears to have been the wooden rails laid down from mines to rivers for the use of carts. The right of thus leading coals off their lands was sold by the owners between collieries and rivers to proprietors, and was known in the north as "way-leave." By the middle of the 18th century the principle had been generally adopted in mines throughout the country, as much as £500 a year being in some cases paid for way-leave. Iron rails were substituted for wooden ones about 1738, and in 1768 the contrivance of linking carriages together was attempted. The first locomotive appears to have been used on a Welsh railway in 1804, and would drag as many carriages as would contain ten tons of bar iron at the rate of five miles an hour; while Stephenson's first locomotive was used on the Killingworth Railway in 1814, eleven years before the opening of the Stockton and Darlington line ("History of the English Railway," by John Francis, vol. i.. pp. 44-53). It might be added that, in 1809 and 1810, a local Act authorised the construction of an extensive system of tramways throughout the Forest of Dean, which has since passed into the hands of the South-Western Railway Company. ("History of Forest of Dean.")

schemes of railway management were remedied by the Regulation of Railways Act of 1840, founded on the Report of the Committee of 1839-40. In 1844, another committee was appointed, of which Mr. Gladstone was chairman, upon the report of which was passed an Act, the 7 & 8 Vict., c. 85, containing provisions, still unrepealed, though never enforced, for the revision by the Treasury of the scale of tolls of railways if, after 21 years from the passing of the Act for the construction of any future railway, the profits should exceed 10 per cent.* The second section of this Act also empowers the Treasury, "at any time after the expiration of the said term of 21 years, to purchase any such railway in the name and on behalf of her Majesty," at the rate of 25 years' purchase of the annual profits; but by the third section, railways in existence at the passing of the Act were exempted from the provisions, both as to revision and purchase. In the following year the railway mania began, and in October and November the *London Gazette*, containing the new Parliamentary schemes, extended over 4,031 pages of double columns, and the advertisements have been estimated to have cost the promoters, at the lowest computation, from £35,000 to £40,000. The capital of the completed railways then amounted to £70,680,887, and in 1846, in spite of the losses consequent on the bursting of the railway bubble, 4,790 miles of railway were authorised, under 272 new Acts. This year witnessed the appointment of two Committees—one of the Lords, and one of the Commons—and the constitution of the Railway Commissioners, by 9 & 10 Vict., c. 105. The Railway Clearing House was established in 1847, and legalised in 1850, by 13 & 14 Vict., c. 33; and a Select Committee of 1853, of which the late Lord Cardwell was chairman, resulted in the passing of the Railway and Canal Traffic Act, 1854. This was followed, in 1863, by the Railway Clauses Act of that year—26 & 27 Vict., c. 92—and since then, the Royal Commission of 1865-7, the Joint Select Committee of Lords and Commons of 1872 and the Select Committee of 1881-2 on Railway Rates and Fares, have dealt with the question of railway management, but, in spite of all the recommendations of these authorities, and of all legislation on the subject, the railway companies have never ceased to grow and prosper, and have succeeded in obtaining the virtual control of the carrying trade of the country. The total amount of our domestic traffic, carried on the railways of the United Kingdom last year, was 270,000,000 tons, or more than three times as great as that of our total cargo trade, which, including our coasting trade, only amounted to 83,000,000 tons,* while the total capital of the railway companies in 1887 was £828,344,254, a sum exceeding the National Debt, and the number of miles of railway open was 19,322.†

* Section 1.

The two Committees of 1846, the Royal Commission of 1865, and the Joint Select Committee of 1872 on Railway Amalgamation, all dwelt strongly in their reports on the advisability of endeavouring to find some counterpoise to check the growth of the railway monopoly. The last-named report, which reviews the whole history of legislation on the subject, begins by pointing out that "In looking back to the history of Parliamentary inquiry and legislation concerning railway amalgamation, and concerning railway competition and monopoly, from 1842 to 1872, it is evident that the predominant idea in the mind of the public has been that competition, which is so powerful a regulator of most commercial affairs, would also suffice to regulate railways; whilst, nevertheless, by a slow and gradual process of experiment one form of competition after another has proved to be inadequate."‡ The Committee advocated the development of our system of inland water navigation, and the freedom of canals from the control of railway companies§; and the same recommendations are repeated with equal force in the reports of the Select Committee of Railway Rates and Fares, 1882; the Select Committee on Canals, 1883; and the final report of the Royal Commission on the Depression of Trade, 1886.||

It was at the time of the railway mania that canals first began to pass into the hands of the railway companies. In 1845, they purchased 78 miles of waterway, 774 miles in 1846, and 96 miles in 1847, making a total extent in three years of 948 miles, a process which they have continued, though in a considerably less degree, down to the present time.¶ A large majority of the nation seem

* See the Address of Sir Bernhard Samuelson, as President of the Association of Chambers of Commerce, at the Annual Meeting, on February 21, 1888.

† See Presidential Address of Mr. George Bruce to the Institution of Civil Engineers, November 8, 1887.

‡ Rep., p. iii.

§ *Ib.*, pp. xxiii., xxiv., xxix., and l.

|| See as to the later Report, pp. ix., x., xxi., xxii., xxv., xxvii. The other reports are referred to later on.

¶ See Report of the Select Committee on Canals, 1883. Evidence of Mr. Calcraft. Q. 16-19, 61-66; Mr. Allport. Q. 1564-69. App. 3. pp. 217-8.

to have been so carried away by the success of the new mode of transport, as almost entirely to ignore the existence of our water communications. Even many of the canal companies themselves — although in 1846 we find canals, such as the Oxford, the Coventry, and the Trent and Mersey, respectively producing dividends of 25, 26, and 30 per cent.— seem to have thought so poorly of their prospects, that they were not only glad to sell on easy terms, but even, in some cases, put pressure upon railway companies in Parliament to compel them to purchase their unremunerative undertakings.* Some of the lesser railway companies, under powers conferred on them by their acts, converted portions of canal into railways, which they used as a means of putting pressure on large railway companies whose traffic was affected by them, to buy or lease from them the whole canal and railway. Other railway companies were forced to purchase canals when applying for powers to make their railway, and others again acquired them, with the sole view of removing all danger of competition.†

By means of processes such as these, more than half of the inland navigation of England and Wales had, by 1872, passed into the control of the railway companies, which have thus, as Mr. Conder points out,‡ "been enabled, in some cases by means of questionable legality, to obtain command of 1,717 miles of canal, so adroitly selected as to strangle the whole of the inland water traffic, which has been forced upon the railways to the great interruption of their legitimate and lucrative trade." At the commencement of the railway movement, the Legislature, as Mr. Conder pertinently observes,§ had the opportunity of either compelling the railway companies to purchase the canals at fair prices, and imposing on them the obligation of maintaining them, which, by relieving their lines from slow and heavy traffic, would have kept down their expenditure by some 50 per cent., or else of prohibiting the purchase or lease of canals by railway companies, and thus maintaining the independence of the former, which would have allowed the traffic of the country to pass into the more economical and convenient channel, as in the case of the coaching and road transport. It elected instead, however, to ignore the existence of canals altogether, when not absolutely compelled to take notice of it, and the results of its consistent adherence to this policy has been the gradual creation for the railway companies of the monopoly of the internal transport of the country, from the hardships of which British traders are now urging it to deliver them.

It will be evident from the foregoing sketch of their history that our waterways and railways have, like so many British institutions, been mainly created by what may be termed "State-aided private enterprise,"* and we venture to think that their defects are mainly to be attributed to the unduly large share which "private enterprise" has had in the transaction. It would be as senseless as unjust to pretend to ignore the vast debt this country owes to "private enterprise," or to attempt to censure the wise reluctance ever shown by the State to assume any control over its action which would even seem in any way to hamper its freedom. Unless, however, duly controlled by the Legislature, public works carried out by private enterprise must always be liable to be injured by the selfishness of competing speculators, and unless conducted on a uniform plan, must always exhibit want of system and confusion of administration, and involve waste of money and material. It is owing to this reason that the internal communications of Great Britain have been developed, not on the principle of providing the public with the cheapest possible modes of transit and transport, but with the object of providing the largest possible profits for competing companies and their shareholders, and that, in consequence, our railways have been constructed and maintained at a greater cost and return a smaller profit than those of any other nation in the world.† Where public works are thus entrusted to rival speculators on whom the State has conferred special powers of acquiring and utilising the property of individuals, the result must always be that at which Great Britain has now arrived—the creation of a monopoly

* See Report of the Select Committee on Railways and Canals, 1883. Evidence of Messrs. Calcraft and Allport. Q. 16-19, 61-66, 1564-69.

† See "British Railways and Canals," by "Hercules," pp. 95, 96.

‡ Report of the Select Committee on Canals, 1883. App. 11, p. 238.

§ *Ibid.*

* It will, I presume, not be contested that the extensive privileges of acquiring lands, &c., conferred on railways and canals by the Legislature constitute quite as important a form of State aid as paid subsidies to them would do.

† See Report of the Select Committee on Canals, 1883, App. 10, p. 233, and a paper read at a meeting of the Statistical Society, on November 16th, 1886, by Mr. J. S. Jeans, on "The Cost and Conditions of Railway Traffic in Different Countries."

in favour of the richest and most politically influential competitor.* The law of "the survival of the fittest" applies quite as strongly in the commercial as in the natural world, and a remarkable instance of the principle of "natural selection" is presented in the mode in which the great main lines of railway have gradually absorbed all the minor county lines and branches. This process, which but for the crushing weight of railway influence, would doubtless also have long since taken place in the case of waterways, must, in the long run, have the effect of excluding private enterprise, in the fullest sense of the term, as completely from the field as if railways and waterways were the property of the State. Lastly, where private enterprise is State-aided, the State must always eventually find itself forced, however unwillingly, to assume more and more control over the undertakings it promotes, and to establish central authorities for managing them efficiently, and we thus find that the Local Government Board has gradually become a central authority for roads, the Board of Trade for canals, and the Railway Commission for railways.

There seems little doubt that the tendency of modern civilisation, with its complex organisation, and its demands for perfect freedom of intercourse—a tendency evidenced both by legislation and public opinion—is to throw the care of our great highway systems ever more and more upon the State, the capacity of which to manage them in the interests of the public is sufficiently shown by the success which has attended the working of the telegraph and savings bank systems by the Post-office. The internal communications of a country, by whatever means they have been originally formed, must always be considered by the State as great national engineering works, constructed for facilitating intercourse between all portions of the kingdom to the fullest possible extent; and engineering works, to be of any real value, require, above all others, to be designed, executed, and maintained upon broad and scientific principles. Unless this policy can to some extent be adopted, there appears at present every prospect that our waterways will cease to exist, and that the commercial prosperity of Great Britain will be dependent upon the sole will and pleasure of the railway companies and their shareholders.

* This is well illustrated by the history of the cost of traffic between Liverpool and Manchester, since railways and canals began to compete. Before the opening of the Bridgewater Canal the charge was 40s. per ton by road, and 10s. per ton by water, between the two places. Then the cost necessarily fell to about 1s. 8d. of the cost by road, owing to the cheapness of water transit. No sooner, however, had the canal companies secured a monopoly, than they began to raise their charges, and, in 1882, the freight cost had risen to three times what it had been in 1795. It might have been supposed that the creation of railway competition would have necessarily lowered the cost of transport, but we find, on the contrary, that it costs more, 50 years after the opening of the Manchester and Liverpool line, to convey a bale of cotton from one city to the other than it did in 1829. (See Report of the Select Committee on Canals, 1883, App. 10, p. 239).

NOTES ON THE MAINTENANCE OF CANALS, WITH SPECIAL REFERENCE TO MINING DISTRICTS.

By G. R. Jebb, M.Inst. C.E.

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I purpose in this paper to describe shortly, in general terms, and as far as possible without entering into engineering details, some of the various works of an ordinary canal in this country, and the methods adopted of maintaining them, making some remarks on the special difficulties which have to be overcome when such a canal passes through a district where extensive mining operations are carried on under and adjoining the canal works.

My remarks will have reference almost exclusively to two systems of canals, viz., the Shropshire Union Canal, and the Birmingham Canal. The former extends from Wolverhampton to Ellesmere Port, on the River Mersey, passing through Market Drayton, Nantwich, and Chester, with branches to Shrewsbury, Newtown (Montgomeryshire), Llangollen (Denbighshire), and Middlewich (Cheshire), the total mileage being 203 miles (see map). Some portions of this canal were made as long back as 1770, some as recently as 1840.

The Birmingham Canal, as will be seen from the map on the wall, forms a perfect network, covering the face of the Black Country of South Staffordshire, and having a mileage of 162 miles, exclusive of some hundreds of private basins. This is a very important waterway. Last year, notwithstanding the depressed state of trade, some 7,000,000 tons passed over it.

The works to be maintained are—the waterway of the canal itself, the embankments, towing paths, locks, bridges, tunnels, aqueducts, culverts, weirs, sluices, buildings, cranes, wharves, warehouses, docks and quay

walls, reservoirs and works in connection with water supply. The width and depth of the waterway vary slightly on the different sections of these canals, the average top width being 36 feet, depth 5 feet, with bottom width sufficient for two loaded boats to pass. A considerable length of the Birmingham Canal has a towing path on either side, the water way has a top width of about 40 feet, and the sides are walled.

Canals, from the slipping in of the sides, the discharge into them of water laden with silt and detritus from cuttings and high lands, and a variety of other causes, are constantly tending to silt up. When the material deposited is soft, it is most economically dredged out at a cost of from 5d. to 9d. a ton, including unloading, but if hard, the water is taken out of the canal and the material excavated by pick and shovel, when the cost is from 10d. to 1s. 2d. a ton, according to the distance the stuff has to be hauled.

A large number of what are called "Spoon dredgers" are constantly kept at work, and the dredging is done generally by contract, at a cost of about 8d. a ton, which includes unloading.

Some years ago I bought for the Shropshire Union Company one of Messrs. Priestman's Grab Dredgers, which has given me much satisfaction; there is, however, an objection to its use on narrow canals, owing to its beam being limited to about seven feet, to enable it to pass through the locks. It is necessary to increase its beam when working by attaching baulks of timber or iron pontoons to the sides to prevent its capsizing; the pontoons, however, are soon attached and detached, and the dredger is a very useful machine, and is preferred to the old-fashioned bucket dredger. Under favourable circumstances mud can be dredged and discharged for 5d. a ton.

To prevent the sides of the canal slipping in, and therefore a certain amount of dredging, as well as the refacing of the sides with puddle, waterway walls are often constructed, and I have constructed many miles of such walls of the sections shown on drawings on the wall. I am now chiefly using Portland cement concrete blocks, instead of the blue Staffordshire coping bricks. I would draw attention to the splayed coping, this, when the wall is backed with ashes, effectually prevents the coping being lifted and overturned by frost. The average cost of such a wall is about 7s. 6d. a lineal yard. On some of the exposed parts of the Birmingham Canal, where grass will not grow on the edge of the towing path, the clay facing has to be renewed as often as twice, or even three times a year, the cost of each operation being from 2s. to 2s. 6d. a lineal yard, without taking into account the dredging rendered necessary by the slipping of the old facing into the canal.

One of the most important duties of the canal engineer, and certainly one of the most anxious, is to take all practicable precautions for the prevention of any of the embankments giving way by the overflow of water during heavy rainfalls.

In some districts at such times an enormous volume of water discharges directly into the canal; this has to be got rid of. Self-acting weirs are constructed at convenient points, and these are sufficient to keep the water within bounds at ordinary times; but in times of flood other means have to be used. The old canal "let-off," as it was called, consisted of a wooden frame (fixed in the bed of the canal), to which was attached a hinged-lid; this lid was pulled up by a chain fixed to the lid when necessity required—that is, if the chain could be found, and also sufficient power obtained for the purpose; for when the let-off had not been used for a considerable time it became covered with mud, and it was often as much as half-a-dozen men or a horse could do to pull up; this accomplished, however, the water rushed out at once with great force (as there was no means of regulating the discharge), the sudden rush often causing trouble with the owners and occupiers of the adjoining lands. I have replaced some scores of these old let-offs by sluice valves of similar capacity, worked by racks and pinions. The discharge of water can thus be exactly regulated, and one man only is required to work them. The valves are tested every month to see that they are in working order.

For the proper and economical maintenance of the towing paths, it is necessary to have a staff of experienced men. I do not think there is any better material for metalling than limestone *débris*, or what is locally known as "raffil" or "bavin," it sets soon, and lasts for years if properly laid down—broken furnace cinders, covered with good ashes, are largely used in the Black Country—the paths should, of course, be well drained.

The locks are about 78 ft. in length and about 7 ft. 4 in. in width, but they vary considerably. Almost every canal had its own particular type of lock-gate, paddle, paddle-

gearing, &c.; there used to be some ten or twelve different types on the canals under my charge. I am gradually reducing them where practicable to the types shown on drawings exhibited.

I would here state that the advantages gained by adopting, when possible, uniformity in the details of machinery, gearing, &c., are enormous, as everyone will admit who is, or has been, obliged to keep in stock a great number of different patterns and castings, differing perhaps so slightly as to make mistakes and confusion almost unavoidable.

Various schemes have been devised for doing away with locks. On the Shropshire Union Canal there is an old incline, along which what are called tub-boats, carrying five tons, are conveyed up and down upon an iron cradle running upon a line of rails. The loads being chiefly down hill drag the empty boats up by means of a wire rope passing round a pulley at the top of the incline. This incline is probably 100 years old, and is working to this day. A stationary engine, fixed at the top of the incline, is required to start the cradles.

On the Monkland Canal, near Glasgow, large empty barges are hauled up an incline in water-tight caissons, the loaded barges going down a flight of locks parallel to the incline.

On the Weaver Navigation there is at Anderton a hydraulic lift which lifts or lowers barges vertically from one level to another, the barges floating in a caisson or tank.

I have prepared a design for an incline somewhat on the principle of that on the Monkland Canal, but so as to convey both loaded and empty boats, and it is under consideration whether one or more of these inclines shall be constructed on the Birmingham Canal, with a view of giving relief to some of the locks where the traffic is exceptionally heavy, and at the same time of economising water.

Canals are supplied with water chiefly from artificial reservoirs, constructed for the purpose, and which the ordinary winter's rainfall is sufficient to fill, but, not uncommonly, water is diverted directly from rivers and streams into the canal, and in some cases, when, from the nature of the country, it is impossible to obtain sufficient water by these means, recourse is had to pumping back the lockage-water, thus using it over and over again.

The chief sources of water-supply to the Shropshire Union Canal are:—

1. Bala Lake, a natural lake, about 1,100 acres in extent, which at present can be dammed up by moveable sluices, about 2 ft. 2 in. above its lowest summer level (the canal company have Parliamentary power to raise the dam indefinitely). The supply for the canal is first discharged into the River Dee at Bala, and abstracted from that river into the canal at Llantisilio, near Llangollen.

2. Two mountain lakes in the Areing mountains.

3. Belvide Reservoir, of nearly 200 acres, near Brewood, in Staffordshire.

4. Knighton Reservoir (37 acres), also in Staffordshire.

5. The River Severn, the water being at one point pumped into the canal from the river, and at another, diverted by means of a weir and feeder.

6. The River Tanat, conveyed to canal by a feeder.

On the Birmingham Canal there is a large reservoir, of 182 acres, on Cannock Chase; another of 62 acres, at Birmingham; and some smaller ones. A large quantity of water is also pumped from the coal-mines, and discharged into the canal, but this company, whose canals for the most part are constructed on high levels, have to depend chiefly on pumping back the lockage water when it has done its work by passing boats from a higher to a lower level, or *vice versâ*, and also by pumping water into the reservoirs from the canals, when there is any surplus.

On the Birmingham Canal there are various pumping stations. The highest main-level canal, called the Wolverhampton level, is 473 feet above Ordnance datum, the different branches on this level have an aggregate mileage of 53 miles, exclusive of private basins. The Birmingham level, 453 feet above the same datum, has a mileage of 35 miles; and the Walsall level, 408 feet above Ordnance datum, has a mileage of 20 miles. A very large amount of traffic daily passes between the Wolverhampton and the Walsall levels, and the lockage water is pumped back at Ocker Hill, near Tipton, and at Walsall.

At Ocker Hill there are six large pumping-engines, and at Walsall three; these, during the summer months are usually all at work day and night, and are capable of pumping about 1,500 locks full of water per diem, each lock being reckoned at 25,000 gallons.

At Smethwick, two engines pump from the Birmingham level into the Wolverhampton

level. At Perry Barr, a set of three engines pump into the Walsall level from the Fazeley branch of the Birmingham Canal, near Birmingham.

Two engines at Titford (near Oldbury) pump from the Wolverhampton level into the Titford Canal, and any surplus water arising on this canal can be run, by a feeder $3\frac{1}{2}$ miles in length, into the Rotton-park Reservoir at Birmingham.

Two engines at Birmingham pump directly into the same reservoir from a feeder running from the Wolverhampton level at Smethwick. A large engine pumps into the Cannock Chase Reservoir from the Wolverhampton level, discharging 550 gallons at each stroke. There is one engine at Sneyd (near Bloxwich), which can pump either into the Wyrley Canal or into the Sneyd Reservoir; and one at Park-head, pumping into Wolverhampton level from a lower level, and one at Ashted (Birmingham), for pumping back the water which passes down the Ashted Locks.

In all there are 24 engines and 45 boilers. These engines are capable of pumping no less a volume of water than 3,713 locks (upwards of 92,000,000 gallons) per diem; it is not at all unusual for upwards of 2,000 locks per diem to be actually pumped.

To prevent water being run to waste, when a length of canal has to be emptied for repairs, a machine, called a "Pump-boat," is fixed in grooves at one of the bridges, and the water is thrown by the fans from one section of the canal into the adjoining section. A mile of canal can be emptied by this machine in about six hours.

There is one other point with reference to the supply, or rather the consumption, of water on canals which is interesting and not unimportant, and about which, strange to say, canal people hold various opinions, as your distinguished members, Sir Douglas Galton and Sir Frederick Bramwell, will bear me out. The point is this. Does it require more or less water to pass a laden or an empty boat through a lock? And does it make any difference whether the boat is passing in one direction or the other, *i.e.*, up or down? There can, I think, be no doubt about the answer.

Let us, for simplicity, suppose that the traffic is all in one direction, say from the higher to the lower level, and that no boats, not even empty ones, pass in the contrary direction (of course this never happens in practice), then the quantity of water required to pass each boat through the lock would be a lockful of water, minus the displacement of the boat. If the boats were all going in the contrary direction, *i.e.*, from the lower to the higher level, a lockful of water, plus the displacement of the boat, would be required for each boat.

It follows, from what I have said, that if the bulk of the traffic on a canal is going uphill, as it is called, much more water is required to pass the traffic than if it is going down hill. Supposing each loaded boat carried 35 tons of merchandise, it is clear that 70 tons (= 15,680 gallons) more of water would be required to pass such a boat up than to pass it down under similar circumstances. On nearly all canals the loads are greater in one direction than the other.

I will now refer shortly to the effect of mining operations on canal works. The chief measures of coal worked in South Staffordshire are, in descending order, the following: — Brooch coal, Thick coal, Heathen coal, New Mine coal, Fire Clay coal, Bottom coal.

Besides these there are some other seams of coal, and various seams of ironstone. Limestone is also worked by mining. The surface of the South Staffordshire mining district is, speaking generally, covered with a thin bed of clay, which overlies a very valuable bed of marl of great thickness, which is largely used in the manufacture of the widely-known Staffordshire blue and brown bricks.

It is not usual, when land is bought for the construction of a canal, for the minerals to be purchased at the same time, but the mine owner is bound by the Act of Parliament to give notice to the canal company of his intention to work any mines, or minerals, under and within a certain prescribed distance of the canal works; this distance varies on different canals, and the length of notice also varies. On receiving the notice, the canal company are entitled to inspect and survey the underground workings, and may at any time prevent the working under any part of the prescribed area by agreeing to purchase the mines. If the canal company do not, before the expiration of the notice, inform the mine owner of their intention to purchase, he is at liberty to proceed with the getting of the mines, and in that case he is not liable as a general rule (but there are exceptions) for any injury that may be done to the canal works.

The Birmingham Canal Company do not usually purchase the mines except for the protection of important works, such as tunnels, large bridges, &c.

The celebrated thick or 10-yard coal has been worked for generations, and there is now comparatively little of it left in its maiden state. When the coal is worked for the first time, large ribs and pillars are left for the support of the roof of the mine, the ribs being several yards in thickness, and the pillars from 8 to 10 yards square. It is the subsequent working of these ribs and pillars and the working of the subjacent measures (chiefly the heathen coal) which do the greatest injury to the canal works. In the first working of the thick coal, although there may be, and is, a considerable amount of subsidence, the swagging (as it is called) of the surface is gradual and comparatively regular; but in working, say, the heathen coal in an old colliery, the old workings of the thick coal, generally only a few yards above, are greatly disturbed, and the pillars, often much reduced in size by repeated "pickings," give way, and large areas of the roof fall in, occasionally causing the towing-paths and embankments to subside suddenly, and it is only by the strictest care and watchfulness in such circumstances that the water in the canal is prevented from escaping over the banks. I have known an embankment 35 feet in height subside no less than 8 feet in a week for a considerable distance. At such times the stop-planks are put in every night at the nearest bridges on either side of the portion of canal that is being affected, and the place is watched day and night.

When the mine workings are shallow, *i.e.*, at a short distance from the surface, what is called "a crownings in" often takes place, a funnel-shaped depression being formed on the surface, and, of course, if this should happen immediately under the canal the colliery is flooded. It has been held in such an event, provided there has been no negligence on the part of the canal company, that the mine owner cannot recover compensation for the damage he may sustain.

One of the drawings shows a cross-section of the canal, where originally it was constructed in 15 feet of cutting, *i.e.*, the adjacent ground was 15 feet. higher than the level of the water in canal. The present level of the ground is 15 feet below the water level, or on an embankment of 15 feet, showing a subsidence of 30 feet. There are many places in South Staffordshire where the surface has sunk as much as this.

The cross-section shows how the canal has been maintained. When the first swagging began, a puddle wall, 3 feet in thickness, was constructed on either side of canal, with a slope of puddle on the canal side, and these puddle walls were raised from time to time as required, the space between the slopes being filled up with mud dredged out of other parts of the canal, or with marl. Either of these materials is better than clay, as they seal up more readily any incipient cracks in the puddle walls. Of course, embankments have to be formed outside the puddle, and raised and strengthened as the ground goes down.

Another drawing, No. 9, shows a cross-section of a swagged canal, where the towing-path had previously been protected by a water-way wall. Here both the wall and the puddles had to be raised, and the space between filled in with mud, or other material, as in the former case. It is better, if great subsidence is expected, to take out the wall, and make an inner slope of puddle.

The effect of mining operations on bridges is very disastrous, the brickwork and masonry being rent and fissured from top to bottom. Arches very soon succumb, and are invariably replaced by flat tops of iron or timber, which can be easily raised by either screw or hydraulic jacks. This raising and re-building of bridges is continually going on, and it is sad to see good work pulled to pieces and wrecked, in a few weeks or months after it is done.

There are several long tunnels on the Birmingham Canal system, having an aggregate length of $6\frac{1}{4}$ miles. Two of these — the Dudley Tunnel and the Netherton Tunnel (see drawings and photos) — pass under the Rowley Hills, and are each about two miles in length. The former was constructed in the last century; the water-way is about nine feet in width, and there is no towing-path, the boats being propelled by two men, lying on their backs on the boat, their feet performing a sort of walking motion against the sides of the tunnel, this is called "legging."

The Netherton Tunnel was constructed in the year 1858; it has a water-way 17 feet in width, with a towing-path five feet in width on either side. Both of these tunnels have, from time to time, been seriously injured by mining operations, and, in the case of the Netherton Tunnel, the injury was caused by the mine-owner illegally working minerals that had been previously purchased by the canal company.

Buildings of all sorts suffer much from mining operations, but it is astonishing how

long the walls will hold together. It is quite common, as the ground sinks, for the lower storey to be filled up to the original first-floor level, the roof raised, and a new upper storey built. Houses and buildings are seen standing at all angles, and the inmates think very little of the inconveniences of large cracks in the wall, uneven floors, and of the risk of the house coming down (see photos).

It is always better, when swagging is expected, to build warehouses, stables, &c., of timber which can be readily lifted.

With regard to the width of minerals which it is necessary to leave unworked, from 30 to 44 yards on either side of the medial line of canal is, under ordinary circumstances, in South Staffordshire, generally sufficient when the mines are in their maiden state, and at the ordinary depths, say from 100 to 200 yards. A rib, 88 yards in width (44 yards on either side), has been acquired for the protection of the Netherton Tunnel, but when the coal has been previously worked the conditions are so complex as to render the question an exceedingly difficult one, and it is often quite impossible to determine, with any degree of certainty, how far old workings may be disturbed by new operations.

Quite recently one of the arches of the aqueduct which carries the Wolverhampton level over the Netherton Tunnel branch, was cracked seriously by the working of the brooch coal (4 feet in thickness), at a point at least 65 yards from the aqueduct. The brooch and thick coal had been worked up to and under the site of the aqueduct many years previously, and before the aqueduct was constructed, which was in the year 1858; from that time till a few months ago no mining operations had been carried on, and the aqueduct had not been injured. The mere re-opening of the old brooch workings, at the great distance I have mentioned, caused a rent in the arch and other unlooked-for damage to the surface. While in another district where, as far as can be known, the circumstances and conditions are similar, no such effect is produced. Often the decay of old timber props, or the pumping of water, causes swagging in unlooked-for places.

By the kindness of Mr. E. B. Marten, engineer to the South Staffordshire Mines Drainage Commissioners, I am able to show you a series of photographs of "swags" in the Black Country, as they existed before they were drained by the works of the Commissioners, and also other photographs of some of their new water-courses. The Commission was established some 15 years ago by an Act of Parliament, for draining the water-logged mines, and for preventing, as far as possible, surface-water getting into the mines.

Mr. Marten says, "The expenditure on surface works, including maintenance for ten or twelve years up to June, 1887, was about £200,000. The total length of streams dealt with has been 300 miles. The actual swags, or water surface drained, has not been closely measured, but have been about 1,000 acres, but the surface drained when there was no outlet but the mines, must have been five square miles. There were at one time eleven square miles which could drain only into the mines, but by improved outfall these have been reduced to about seven square miles, and this is mostly dealt with by surface pumping to lift the water from low points to the nearest stream."

Many questions have from time to time arisen between the Commissioners and the canal company, which, owing in a great measure to the fairness and courtesy of Mr. Marten, have been satisfactorily settled.

In conclusion, I have to express my regret that, partly owing to the pressure of other work, I have not been able to arrange these notes more carefully, and to make them more interesting.

The CHAIRMAN proposed votes of thanks for the papers, which were unanimously accorded.

Mr. J. H. TAUNTON (Brimscombe, Gloucester), asked if figures could be given showing the cost of maintenance per mile on the distances mentioned in Mr. Jebb's paper.

Mr. SAMUEL LLOYD said that Mr. Cotsworth stated in his paper that nothing had been done until 1423, when the first Act was passed, and that before that date no trace had been found of any earlier canals, but a canal had been constructed in 1134. So far from it being the fact that after 1815, as stated, immense progress was made in the home industries, an immense depression continued for some years after the great wars.

Mr. TAUNTON wished to add, as Mr. Cotsworth had referred to the Thames and Severn Canal, and differences of gauge existing, that the engineer in that case had to accommodate the traffic which passed from the Severn with that which passed upon the Thames. The coasting barges which passed up the Severn were generally 16 feet wide, and the

Thames barges were only 12 feet wide. The engineer determined that the break of gauge should be at the greatest possible distance inland before the country began to rise rapidly. It was impossible, on account of cost of construction, that he could have carried a 16-feet canal through the whole district, and, therefore, he had determined to carry it as far as he could. Probably the same reasoning applied to other canals reaching the coast. Mr. Cotsworth had referred to the fact of there being no locks, originally on the Stroudwater Navigation, but only an expedient for passing through instead, but that did not long continue, and locks had been constructed.

Mr. THOMAS (Regent's Canal) asked Mr. Jebb what improvements he had introduced into the construction and working of his canal since he had been engineer.

Mr. G. R. JEBB said he had not the figures showing the cost of the maintenance, but there could be no comparison between the cost for the Birmingham Canal, which was being constantly undermined, and such canals as the Shropshire Union or Grand Junction; the first mentioned would probably be ten times as much as the other, but he could not give the figures. With regard to lock-gates, the drawings he exhibited showed the lock-gates he had adopted on the Shropshire Union and Birmingham Canals, but it would take too long to describe them in detail. The bottom gates were solid oak, and the top gates were of oak, framed and planked. As to the improvements he had made on the Birmingham Canal, he would only say generally that he had built many miles of waterway walls, had replaced many timber bridges by iron ones, and that the floating capacity of these canals was much greater than it had been for many years. The towing-paths also had been greatly improved. The lock-gates shown were somewhat similar to those which had always been used, but with several improvements, chiefly in matters of detail; which however were very important. All new gates were being made of these types.

Mr. HARRIS (Leeds and Liverpool) said in reference to the subsidence of Mr. Jebb's canal in consequence of the coal-workings, it appeared to be considered necessary for them to buy the coal in order to avoid the risk of subsidence. He would be glad to know whether they had raised the question of their being obliged to do that, or whether on the other hand the colliery proprietors were not responsible for dangerous working.

Mr. JEBB said he must decline to enter into a legal discussion as being quite outside his own domain.

Mr. AITKIN, who had been engaged for some years in the construction of the canal mentioned, asked whether the brickwork of the Netherton tunnel had been injured, or had at all sunk in from the working of the coal.

Mr. JEBB said injury had arisen from it some 15 or 20 years ago. The greatest amount of sinking was about 20 inches. Within the last few years the towing-path had been raised to its original level; but that, of course, had decreased the headway between the surface of the path and the arch—still it was quite sufficient.

Mr. TENNANT inquired as to the best way of contending with the growth of weeds in summer?

Mr. JEBB said in the country he kept swans. That might be done, or the American weed should be left to choke itself; the more it was pulled out the more it would grow. The plant does not seed in this country, and in many districts is far less troublesome than formerly.

Mr. TAUNTON, speaking as to the comparative cost of canals which were maintained by railway companies and those in the hands of the canal companies themselves, said the Kennet and Avon was maintained by the Great Western Railway Company. The cost of proper maintenance should be some hundreds of pounds per mile, but according to the company's published accounts they spent upon that important barge canal the magnificent sum of £88 per mile per annum. Then on the Monmouthshire, Brecon, and Abergavenny, &c., Canals, a 10 feet waterway, with a length of 54 miles, the sum of £51 per mile was spent. Taking next an independent narrow canal, held by a not very rich company, the Worcester and Birmingham, in 1886 they spent upon it £178 per mile per annum, and in 1887, £179 10s. Next, to take the case of a canal well-maintained by a railway company, the Trent and Mersey, partly narrow and partly a barge canal of 121 miles, that was maintained at a cost of £130 per mile per annum at the least.

Mr. JEBB was glad to have the opportunity of stating that both the Shropshire Union and Birmingham Canals were maintained in the utmost state of efficiency. He should not be afraid of comparing them with any other canals in the country, and more money had been spent upon them during the last 12 or 15 years, while he had been engineer, than he believed had ever been spent upon them while they were independent canals.

The CHAIRMAN mentioned that the figures were all published.

A MEMBER said the large amount of money spent in maintaining the Worcester and Birmingham Canal was unremunerative, for lack of an extension from the lower section of the canal to the sea.

INLAND NAVIGATION IN GREAT BRITAIN.

By Edward John Lloyd, M.Inst.C.E.

[Engineer and Manager of the Warwick and Birmingham and Warwick and Napton Canals.]

With the exception of some early works in the Eastern Counties, which were probably partly of a military character and partly also in the nature of drainage outfalls, the early improvement of river navigations was commenced, as was natural, by extensions of the navigable channels in the estuaries, and probably most of our rivers were to some extent improved by the removal of shoals, and the construction of rude works for the purpose of damming up the water temporarily to a navigable depth. Even to this day, these rude methods have survived in some of the rivers where the traffic is small, and the revenues have not been sufficient to warrant more costly works. In their natural condition, none of the rivers in this country were of sufficient depth, in ordinary dry weather, to enable navigation to be carried on effectively by craft drawing more than about three feet of water, and in any improvement of the main or tributary channels this depth appears to have been considered sufficient.

All the early locks were therefore adapted to pass a broad shallow vessel, such as had previously been used in the river basins subjected to this partial improvement, and, as a consequence of this, each river basin had craft of different dimensions, which from local circumstances had been found most suitable and economical.

Subsequently, the gauge of the smallest lock in each area became the gauge to which the craft were built, and thus a number of different gauges, varying in length, beam, and depth were established, and have been, for want of legislative regulation, most unfortunately perpetuated.

Even on the same rivers there were, in some cases, further sub-divisions of gauge, and upon the Thames, below Oxford, there are now locks of four different dimensions, one of which has been added within the past few years.

Similarly on the Severn, which, until about the year 1844, was an open river channel without locks, four different sized locks have been introduced on the improved works; whilst on the Gloucester and Berkeley Canal, which forms an extension of the river navigation to the deep water of the Bristol Channel, another gauge (not identical with any one in the upper navigation) is to be found.

In like manner the canal navigations, even those forming different links in one route, vary in size, and single canals have more than one gauge of lock.

Upon a considerable area in the Midland Counties, extending from the Mersey on the north to the Thames on the south, and comprising nearly all the most active and prosperous canals within that area, a small gauge of 72 feet by 7 feet lock has been adopted, and on many other canals, which have larger locks, boats of this size largely prevail.

Throughout this area, the different summit levels attain a considerable elevation above sea level, and the water supplies are obtained from small and in many cases insignificant, streams, supplemented by impounding reservoirs, and by pumping.

In the construction of these small canals the object, no doubt, was twofold.

1. The reduction of the amount of capital necessary for the works.

2. The amount of traffic contemplated being small, and from circumstances related in the Acts of Parliament, altogether out of proportion to the amount since attained, it was believed that the water supplies would prove sufficient, which would not have been the case if larger locks had been adopted.

This gauge was first adopted by James Brindley, and the first lock of these dimensions is said to have been erected on the Staffordshire and Worcestershire Canal, near Wolverhampton. The Harecastle Tunnel, on the Trent and Mersey Canal, was also built of a width to pass a boat capable of being worked in the narrow gauge canals which were then constructed under Brindley's supervision to join the Midland, South Staffordshire, and North Staffordshire mineral and manufacturing districts with the River Thames at Oxford, the Trent at Shardlow, the Severn at Stourport, and the Mersey at Runcorn, and including the Oxford Canal, the Coventry Canal, the Birmingham Canal Navigations, the Trent and Mersey Canal, and the Staffordshire and Worcestershire Canal. Probably no other instance can be found of such a grand commercial success as this system of canals afterwards proved, although the construction was delayed by want of capital, and in one case, viz., the Coventry Canal, a part of the original undertaking was handed over to another company for execution, and the undertaking still remains disjointed and incom-

plete, as a section five miles in length, between the two terminal portions, is owned by another canal company, which has accepted a railway guarantee, and disposed of the control of its revenues; yet the dividends paid have amounted to a fabulous sum, and they are all still making fair, and in some cases large, returns on the original outlay.

The design of this system was consequent upon, and immediately followed, the opening of the Duke of Bridgewater's Canal between Manchester and Runcorn, into which the Trent and Mersey Canal was joined at Preston Brook, and that grand work was thus the precursor of the inland canals of the kingdom.

Urged on by the marvellous success thus attained by the Duke of Bridgewater's navigation and by Brindley's system of canals, the public were induced to take up projects for canals in almost every direction, and between the years 1790 and 1795 a mania raged for canal construction in every possible direction, and canals were constructed which have been either partial or entire failures. Nevertheless, many of these projects proved of great public utility, and have been fairly, and in some cases very successful. Of the more important, the Grand Junction Canal, which joins the Oxford Canal at Braunston, and passes through Northamptonshire, Buckinghamshire, Hertfordshire, and Middlesex to the Thames tideway at Brentford, with important branches to Aylesbury, Buckingham, and Northampton, and with an extension to the western side of the metropolis at Paddington, was one of the most important.

The Regent's Canal, which forms an extension of the Grand Junction Canal from Paddington to the Thames at Limehouse, was commenced in 1812, and completed about the year 1820.

To this may be added the Ashby Canal, the Derby Canal, the Nottingham Canal, the Worcester and Birmingham Canal, the Dudley Canal, and the Warwick Canal, all of which formed important connecting links or branches in extension of the canal systems already constructed.

On the northern side of the Mersey another great canal undertaking was constructed as the outcome of the Duke of Bridgewater's success, and the Leeds and Liverpool Canal may be cited as perhaps a bolder and more gigantic project than any other which had been then undertaken. This canal, which is 144 miles in length, and has a summit level about 450 feet above the sea level, joins the Mersey at Liverpool with the Aire and Calder at Leeds Bridge, and the latter navigation, which had already been in use for nearly 50 years before the first Canal Act was passed, carried on the navigation from Leeds to Selby.

No better example of the value of enterprise in inland navigation can be adduced than this undertaking, originally constructed with locks 60 feet long by 15 feet wide, and with a depth of three feet six inches. It has been subsequently twice reconstructed in all its main features. In 1820, the diversion between Knottingley and Goole was constructed, with locks 72 feet long, 18 feet wide, and with seven feet depth of water, but, this being found inefficient, the whole of the works between Goole and Leeds, on the Aire branch of the Navigation, and Wakefield on the Calder, have been again reconstructed, with locks of 215 feet long, 22 feet wide, and nine feet on the sills. In addition to this, the undertakers have purchased and improved the Barnsley Canal, and also, to some extent, as lessees, they have extended their improvements to the Calder and Hebble Navigation. From time to time, the port of Goole, which forms a part of the Aire and Calder Navigation, has been improved, and its capacity enlarged, new docks and entrance-locks have been built, and the channel generally improved. The commercial results of these improvements are not accurately known to the public, as the undertakers do not publish their accounts, but it cannot be doubted that the success has been more than equal to the expectations formed by the owners.

Mr. Bartholomew, who has for many years been engineer and manager of the undertaking, has given very full particulars of the traffic carried, and the cost of carriage, in his evidence before the Select Committee on Canals (1883), of which Thomas Salt, Esq., was chairman, in which results are shown which, whilst they prove the immense value of improved canals, also show that even more might be attained, in return for the great enterprise and expenditure of the undertakers, if the same spirit was exhibited by the other canals and navigations which form connections with theirs, and complete the routes between the east and west coasts.

In this portion of the kingdom the mania of 1790 took considerable effect, and canals were projected which form valuable links of communication. Of these the principal were the

Rochdale, from Manchester to Sowerby-bridge, where it joins the Calder and Hebble Navigation, thus forming another route between the east and west coasts, and the Huddersfield Canal and Ashton-under-Lyne Canal, which, together with Sir John Ramsden's canal from Huddersfield to Cooper's-bridge, formed yet another line of canal between the east and west coasts.

Looking further to the east, a canal from Chesterfield to the Trent had been projected by Brinsley some years previously, and having been commenced just previously to his death in 1772, it was completed about 1776. In the same district the Dearne and Dove Canal and the Stainforth and Keadby, from the Barnsley coal field to the Trent, were the outcome of the mania of 1790; and in the west the Ellesmere Canal and the Chester Canal, which now are part of the Shropshire Union Canals, were commenced by Brinsley in 1772. Their construction lingered for want of capital, and was not finally completed until 1832. Upon the amalgamated Ellesmere and Chester Canal some of Telford's finest canal works were constructed.

In 1826, a canal called the Birmingham and Liverpool Junction was projected from the Staffordshire and Worcestershire Canal near Wolverhampton, to join the Ellesmere and Chester Canal near Nantwich, and there to form another and nearer route from South Staffordshire to the Mersey, and this was completed about the year 1834.

In the south, the Kennett and Avon Canal, from Bath to the Thames at Reading, and the Wilts and Berks, from Semington on the Kennett and Avon to Abingdon on the Thames, with a branch to the same river near Cricklade, were also the outcome of the canal mania of 1790; but neither of these canals was ever any considerable commercial success, and it is a curious fact that the Wilts and Berks joins three canals and river navigations, all of which had locks sufficiently large to pass river barges, yet on this intermediate link the locks are only 7 feet wide.

A very extraordinary result of the public anxiety to invest in canals, at the time so often mentioned in the foregoing notes, was that a system of bar and compensation tolls was created, and a right to levy them on the traffic of the newly-constructed canals was granted to the existing canals ostensibly as a protection to their existing monopolies, and so extravagant were these compensations that it was found in several cases that within a few years canal companies received more than the amount of their original capital by way of compensation for injury to their traffic. The fact that all these new lines of canal could only succeed by bringing tributary traffic not otherwise attainable to the older canals seems to have been completely lost sight of by the Legislature, and no excuse appears to have been too absurd as a reason for granting these oppressive and unjustifiable exactions on the trading public. Many instances might be mentioned, but it may be stated by way of example, that in one case 11½d. per ton was granted where the traffic did not pass within four miles of the existing canal, and in another 6d. per ton, where the distance exceeded five miles. To these may be added bridge tolls, which were exactions payable by goods, which having been landed, or were intended to be carried on one canal passed over the bridges of another and older company.

Whilst the canals had practically a monopoly of all the traffic of the kingdom, it was not so serious a matter to their interests that these heavy burdens were placed upon their traffic. No doubt the public were the sufferers, but the weight of traffic passed was, in most cases, such as to enable the canals to earn dividends satisfactory to their shareholders, and they were therefore, more or less, careless of the public interests, and viewed restriction of trade very differently from what they can now afford to do, when they have to keep up a constant competition with railway companies for their traffic.

The total abolition of all bar and compensation tolls, and the establishment of free trade by the introduction of through mileage tolls, seems to be imperatively demanded if cheap canal transport is to be attained in the public interests.

From the earlier years of the present century until about the year 1833, little alteration was made in the canal system, either by the construction of new canals or by any extensive improvement of the works of the existing navigations, the Birmingham and Liverpool Junction Canal, already mentioned, and the Macclesfield Canal, which forms a shorter route from the Trent and Mersey Canal, at Red Bull, to Manchester, being the only works of considerable magnitude undertaken within this period. But about this time further activity commenced, and works of great value were undertaken by the Birmingham Canal Company, and continued, almost without intermission, until the year 1850. Many improve-

ments of their existing lines were executed; new cuts made in substitution for old and tortuous portions of the navigation, an entirely new connecting link made between the Cannock coal-field and the town of Birmingham, with an intermediate junction with South Staffordshire; and, finally, a new tunnel of sufficient width for two boats, and with a towing path on each side of the waterway, was constructed through the range of hills separating the South Staffordshire and East Worcestershire coal-fields, between which the only communications previously available was a small tunnel of nearly two miles in length, only large enough for boats to pass in one direction at a time.

About the year 1844, the navigable channel of the Severn, from Stourport to the estuary, was greatly improved, and subsequently additional locks have been erected thereon.

The Gloucester and Berkeley Ship Canal has also been improved, and a new entrance and dock constructed at Sharpness Point.

Later on improvements were also undertaken on the River Weaver navigation in Cheshire, a navigable channel capable of passing vessels of considerable burthen, having been carried as far inland as Northwich, and a hydraulic lift has been constructed to connect this navigation with the Trent and Mersey Canal at Anderton.

As the canals had a practical monopoly of all the traffic of the districts through which they passed, it will not be thought surprising that they should, in many cases, have paid high dividends, and viewed with great alarm the progress of railway enterprise, and in the year 1845, Parliament first sanctioned the control of canals by railway companies either by amalgamation, lease, purchase, or guarantee, and between that year and 1872 1,250 miles of canal in England were acquired by railway companies, either absolutely or by such agreements and arrangements as enabled them to control their tolls and charges.

It does not appear to admit of any doubt that, whatever may have been the effect in particular cases, the general result has been prejudicial to the public, and disastrous to those canal companies which have remained independent; more particularly has this been the case since the Legislature, by the Railway and Canal Traffic Act of 1873, has practically forbidden further alliances between railways and canals; and whilst no effective control has yet been placed upon the tolls charged for the use of railway-owned canals, the independent canals have been compelled to reduce their charges to an extent which the public demanded, or railway competition dictated, whilst the full amount of toll is in many instances exacted by the railway-owned links of communication.

The question of the future utility of canals is entirely involved in their being made the cheapest available means of transport. They can never compete with railways in speed except within very restricted distances, but they could, if freed from all trammels, be made the most effective means of cheap transport for such goods as are of small value, and which do not require rapid delivery.

The impediments to this which now exist are—

1st. The want of consolidation and amalgamation of the numerous short links now existing under different ownerships.

2nd. The ownership or control by railway companies of portions of through routes, and the consequent inability of the different companies to obtain through tolls over such portions.

3rd. The want of uniformity of gauge of locks, and the restricted sectional area of the waterways.

4th. The want of a uniform classification of goods.

As to the first point, it certainly seems difficult to understand why a canal, which only forms a short link of the communication between a manufacturing district and its natural port, should be under distinct and separate management, involving extra cost and diminished profits, and a vigorous and successful effort to effect an amalgamation, in the same manner as has been done by railway companies, would certainly result in great advantages, and diminish the difficulties which now beset the general improvement of canals. The ownership of many necessary links by railway companies, who hold the canals, prevents a complete arterial scheme being formed, and by controlling the tolls and fixing them at such a high level prevents the through traffic being carried in competition with the owning railways.

The present classification of goods on canals is most anomalous, a low toll is very usually fixed for lime and limestone. This was no doubt done in the interests of the owners and occupiers of land, and to this, in many instances, roadstone was also added.

But with regard to other classes of traffic, scarcely two canals follow even similar lines

of classification. On one canal such goods as pearl shell, coffee, tobacco, silk, and Irish linens are in the lowest class; anvils, axes, cutlery, chains, and kettles are also in this class, but bar-iron, sheet-iron, and coals, which are essential to their manufacture, are in the highest class. On another canal brick and stone forms the lowest class; coal and lime the second; all other commodities the third and highest. Thus any new traffic, even if it be a raw material which can be used in large quantities, and is of the lowest value, and will consequently only bear the least possible transport charge, can be charged as high a toll as the most valuable articles of commerce.

The only remedy appears to be to invest the Railway Commissioners with extended powers by further legislation, such as is now being proposed by Parliament, the greatest care being taken that no loophole shall exist by which a railway-owned canal shall be enabled to secure more than a fair proportion (either by mileage, or in any exceptional case by careful consideration of all circumstances) of the toll recoverable on the whole of the through route. And by legislative encouragement of amalgamation and traffic arrangements amongst canals.

The question of improvement by the reconstruction of locks or other means, of passing traffic from one level to another, and of the most advantageous section of waterway, is one into which careful investigation of all the surroundings must be undertaken before a final decision is made.

The construction of canals of sufficient capacity to pass craft suitable for coasting and short continental voyages, certainly appears to involve such a large capital expenditure as would prove fatal to cheap conveyance and commercial success, but the present gauges are certainly too small to be economical, and do not afford facilities for the use of modern methods of traction.

I am of opinion that a multiple of the present size of lock which prevails throughout the midland district would be best, as it would enable the existing craft on those canals, and also most of the barges on larger navigations, to be used in the most economical way possible, and would greatly simplify the conduct and management of low-class mineral traffic, which does not require any care, and could be treated in a similar manner to traffic of the like description on railways—no crews being attached to the boats, which could be detached from the trains, and left at any roadside wharf, until they could be unladen, at the convenience of the owners.

There is a distinct advantage in small craft for such traffic, as it is obvious that a coal merchant could purchase small boat-loads of different classes of coals, to suit his customers, who could not find capital and wharf space for large cargoes of one class of coal only, and this would apply in equal degree to traffic in road-stone, bricks, drain-pipes, building materials, and many other classes of undamageable goods, and these small craft might also ply successfully on short branch canals, in districts which would not produce a sufficient traffic to warrant a large expenditure in improvement.

Such locks would also, of course, accommodate craft sufficiently large to cross the estuaries of rivers, and to approach any docks with safety, and if sufficient depth of waterway is provided in the improved main lines, say eight feet, or thereabouts, short coasting voyages might also be undertaken by craft specially constructed to do so and also to navigate the canals.

The object to be attained by canal improvement should be to supply the raw material to manufacturing centres, at the least transport charge, and the export from the internal producing districts to such manufacturing centres, or the outports of traffic of a like character, and of minerals and coals, as it is now found that even a very small reduction of transport charge is sufficient to establish a traffic, and enable manufacturers to use materials which have even been regarded as absolute waste.

It is believed that such canal traffic would be carried on by steam traction at a cost which would be unremunerative to a railway company, especially if it was undertaken in the same way as carrying by railway is now done, viz., by the companies themselves, and this again points to the necessity for amalgamation of routes and of the establishment of fair and equitable through tolls wherever amalgamation cannot be effected.

It is not proposed to discuss in this paper the engineering problem, but having given the question generally long and very careful consideration, I have thought it desirable to set out the conditions which to my mind should govern the improvements of the future.

The minimum size of lock should be fixed as it is in France, no new lock being permitted to be constructed which is not equal in its dimensions with the minimum gauge or a multiple thereof, and I suggest as most suit-

able a lock equal to passing at one operation four narrow canal boats. If this is adopted, many of the existing tunnels and bridges will be available, and the waterways will not in many parts require extensive alteration.

Wherever there are great differences in level, mechanical lifts may be adopted, but these means are open to objection, on account of their great first cost, and the long stoppages of the traffic, which any failure of the machinery would involve. The cost of maintenance and working expenses are also greatly in excess of a lockage system.

The waterway of the main lines should be fully equal in every part to enable boats to pass each other, but there appears to be no necessity for a large expenditure of capital for this purpose on branch lines, as by means of telegraphic communication the traffic can now be easily regulated.

Attempts to establish high rates of speed should not be encouraged, as they tend to destroy the works, and are only attainable by considerable additional towing power in waterways of restricted sectional area, and consequently at great additional cost. And, lastly, it must be remembered that the works must be substantial, but plain; the result of improvement must be greater commercial utility, combined with a fair and reasonable return for the capital expended.

PRESENT CONDITION OF INLAND NAVIGATION IN THE UNITED KINGDOM, WITH SUGGESTIONS FOR ITS IMPROVEMENT.

By M. B. Cotsworth.

The present condition of inland navigation is decidedly unsatisfactory, whether viewed from a national, commercial, or shareholder's standpoint. Many of the navigations are to-day in a much worse condition than they were a century ago, whilst, with very few exceptions, almost all are infinitely worse than they were 60 years ago, in regard to their commercial value and capacity for navigation, notwithstanding the enormous increase of traffic and wealth in the country generally. The question naturally arises—Why is this? seeing that all the canals and navigations of 60 and 80 years ago were so prosperous, all paying maximum dividends (some 300 per cent. and more) and accumulationg large reserves. Why is it that such canals as the Grand Junction, with its then toll roll of £160,000, and the great increase in value of its London property, due to the accumulation of "unearned increment" upon it of late years, and the Birmingham Canal, with its old toll roll of £200,000, have not retained their position? Two great reasons may be given for this:—(1) The development of canals has not advanced to meet the requirements of the increased and progressive conditions of trade. They remain the enlarged mud-ditches of the last century, though now very much out of repair and half silted up. The old and obsolete systems of working and management are still in force, whilst steam-haulage and the other great inventions of the century have not been turned to proper advantage. Engineering improvements have been neglected, so that the old difficulties to through-traffic, caused by variety in the width of locks and depth of canals (entailing heavy costs in transhipment and delay), still exist under the divided interests of small local companies. These difficulties are much more keenly felt to-day, owing to the exacting requirements of present traffic, due to altered conditions of trade, and have resulted in the loss of through traffic, which can now be hardly said to exist.

The second reason is the keen and successful competition of railways, which has resulted in the withdrawal of most of the traffic from canals to railways, who have by various means secured the control of 1,239 miles of the most productive canals of Great Britain, leaving 1,403 miles in the hands of private companies. The result has been that canal property, as security or an investment, has fallen to little value, and is scouted by the public, who place upon it values much below its intrinsic worth. I had a striking instance of this last year, when I bought some £83⅓ shares in the Leicester and Northampton Canal at £7 per share, notwithstanding the fact that that company has a reserve fund equal to £9 per share, invested on good mortgage, in addition to its valuable reservoirs, property, and canal, with locks, &c., forming an important link in the through route between London and the Midland coalfield. Again, the Loughborough Canal shares, once worth £4,500 and more, now are scarcely worth £100; whilst the Erewash Canal shares, once worth £3,000 or more, are only quoted to-day at £50.

Canal companies generally see that structural improvements and carrying facilities are necessary to enable them to regain a satis-

factory position, but as canal investment is in disfavour with the public, they are unable to raise the money required.

Now comes the question—what is best to be done? It is clear that, owing to the neglect of our inland navigations, a very considerable trade has been secured from us by Continental nations, who have long recognised the value of inland navigation in its relation to commerce. The consequence is, many of our manufactures are languishing, whereas they might have been flourishing now, if inland navigation had received the attention it deserves. We may instance the coal, iron, and cement trades. Iron is conveyed on the Belgian canals at a cost of 2s. 6d. per ton, the same distance as that for which 12s. 6d. per ton is charged by railway in England. This advantage, together with the low sea-freight, enables the Belgian ironmasters to compete with success for the English iron trade, consequently, we really employ large numbers of men in Belgian foundries, &c., instead of at home. It is just the same with the plaster, cement, and other heavy trades. Immense quantities of this traffic are sent by water from Paris and other Continental districts at a cost of 5s. per ton, or under, to London, whereas we have millions of tons in the mines of the Midland district unworked, because the rail carriage to London of 7s. 6d. per ton prevents the Midland manufacturers from competing with success. One maker in the Midlands told the writer, only last week, that he had lost from 7,000 to 8,000 tons a year of his London trade owing to the advantages the French maker has of cheap water transit. He further stated, that if as good water transit be provided in England he could regain the trade and employ many more hands. From these and other considerations, we may fairly say that the canal question is becoming one of national importance, and demands our most serious attention.

As to the best means of dealing with this question, we must expect to find much diversity of opinion, even amongst the most capable men, according to the knowledge and varied experience they may have had. Many who have knowledge of the French and other continental navigations will strongly advocate that the whole canal and river systems should be taken under Government control, and improved upon a uniform plan; whilst others will advocate amalgamation and improvement by private companies on a large scale. As a sound judgment can only be arrived at by full and free discussion of all sides of the question by practical men, we will proceed to investigate the advantages and disadvantages of each. We should first bear in mind that unity of action, as well as uniformity of plan, are necessary to secure the maximum amount of prosperity and advantage to the kingdom; and, secondly, note that the foremost consideration should be to effectively provide, not only for the existing trade, but also for an immensely increased traffic which is sure to follow if inland navigation is placed on a thoroughly effective footing as regards the cost of transit. As to the amount of tonnage ultimately to be provided for, it is extremely difficult to estimate, as that largely depends upon the cost of transit. When rates are very low, "thousands of things are then discovered to be worth moving which nobody thought of before." We may take it for certain that England, with her unbounded mineral resources, vast manufactures, coupled with her imperial power and wealth, will require such immense facilities of transport as inland navigation alone can supply.

We will first take Government purchase. Considering the immense influence which the cost of transport has upon the trade and progress of a nation, it is but natural that this remedy should first suggest itself, especially when the advantageous results of Government management are so strikingly shown in the working of the Post-office and telegraphs, as also in the example of Government control of canals in France, &c. All who look solely to the interests of the community must admit that this course offers the highest national advantages, and will ultimately prove the best solution. But there are immense difficulties in the way of its accomplishment at present.

Amongst the chief advantages of Government control are the following:—

1. The whole system of "inland navigation" would be developed and worked for the benefit of the nation by a complete scheme, and thus secure for the first time a genuine and permanent competition with railway charges, and so hold them in check.

2. All chances of monopoly, and trade restriction by private interests, would be avoided.

3. Government security would ensure capital being raised at a minimum interest—say $2\frac{3}{4}$ or 3 per cent. and so keep the costs down at a low figure.

4. By adopting a "sinking fund," these navigations might ultimately become free from toll, except a very small charge for maintenance and management.

5. Would facilitate uniformity of classification, toll, and through-rate arrangements.

6. The question of railway-owned canals would thus be settled.

7. Also the difficulty of floods would be removed as far as practicable, and storage of water, for town and other public uses, encouraged by the abolition of vested interests in water rights, fishery obstructions, &c.

8. The above advantages, whilst affording unbounded relief to commerce and the public, would result in increased employment for the labouring classes, and add to the wealth of the nation by creating a revival and permanent expansion of trade—thus relieving our present burdens without imposing new ones.

The following disadvantages and difficulties in the way of State management may be mentioned:—

1. Public opinion is not yet ripened to enable such a proposal to be carried, and it will take some years to educate the people to it. Meantime something must be done.

2. To successfully compete with railways (who have now such a firm grip of the heavy traffic), it is essential that a strong carrying company should be established, on a broad basis, to work the navigations and interchange traffic for towns on the sea-board with the coasting-steamers at through rates.

3. If the Government did not undertake the carrying, private traders would have great difficulty in meeting railway competition, as, owing to the heavy terminal charges they would incur, and costs of agencies, &c., they would be handicapped, whilst railways could sustain their competition against canals, by means of their passenger and other traffic.

4. The patronage being placed in the hands of Government, might be abused for party purposes, and lead to political jobbery, &c.

5. Again, for the good canals a very high price would have to be paid, whilst some of the poor ones would be looked upon as a bad bargain at any price.

6. In justice to the railways, the Government could not assume the responsibilities of carrying without also taking over the railways at their present inflated prices, notwithstanding the £100,000,000 of unproductive capital (land and under-issued stock) with which they are burdened.

7. The present enormous capital of railways, constituting such vested interests in Parliament, and through the shareholders over the country generally, is too strong to allow the Government to take the canals and fully establish them. To do so might be unjust to railway shareholders. This, I think, would be fatal to any such project at present.

Whilst we may take it that a scheme of Government purchase of the whole system of canals is as yet premature, it may reasonably be said, that the case of railway-owned canals has been so strongly made out by evidence before the various Select Committees, that the State would be justified in taking these over at once, in the public interest, with powers to improve them.

Sir Arthur Cotton rightly asks, "What can be more absurd than to pass special Acts of Parliament to establish railways, and then permit those railway companies, with a capital of 20 or 30 millions, to purchase for a few thousand pounds a short link of canal which would give them the power of ruining three or four canal companies, whose traffic was more or less dependent upon that line, and that not for the general public good, but at a cost to the general public of fifty times the profit gained by the railway."

With a view to ultimate "State purchase" all new Canal Acts should contain clauses providing for the following:—

1. Limitation of dividends.

2. Retention of Government power to buy up the canal at a fixed price, within or at the expiration of a fixed time.

3. Encouragement of every sound improvement by spending surplus earnings on navigation.

4. Limitation of reserve fund and property, with provision for lowering toll as traffic increases.

5. Obligation of company to develop the canal trade of the district to the full, failing which Government to have power to take at a simple valuation.

The arguments already given for and against "State purchase" apply with equal force to "Public trusts," to which may be added two further disadvantages:—

1. Would perpetuate divided interests, and stand in the way of full scheme of development, by fostering local jealousies.

2. Public bodies should not be allowed to become traders. Experience is against control by the class of men who push themselves forward upon such bodies (town councillors, &c.), and cause the waste of much public money.

It is important that we should now consider what is within the range of practical effect for giving immediate relief to water-transit, and

best calculated to stimulate further improvement. I incline to think that the only thing immediately practicable is the formation of a powerful and well-organised canal company, which should amalgamate all the canal interests between London and Liverpool, Hull and Bristol, as well as the Midland feeding canals, having compulsory powers to do so, especially with regard to the railway-owned canals. This would abolish local vested interests and jealousies, effect a large saving in management, and by its strength and organisation command the confidence, and hence the support, of the public. Should the monied interests of railways prove sufficiently strong to check the raising of capital—a great difficulty with canals at present—then the Government might fairly be asked to advance the requisite funds, at a low rate of interest, subject to fair conditions, which would prepare the way for ultimate Government purchase. Such a company, by improving these navigations to a uniform and well-considered plan, calculated to provide effectively for present and prospective traffic, as also by the adoption of the best steam-towage, and an efficicient carrying equipment, could successfully withstand any pressure which railway companies could bring to bear against it. With power to enforce through rates on the Lancashire and Yorkshire navigations (the chief of which are the Manchester Ship Canal, Aire and Calder, and Leeds and Liverpool Canals), as well as being in a position of the greatest advantage to arrange low through rates with the coasting and Irish steamers, or provide the steamers themselves, the strength of such a company would be unexampled. Some idea of this power may be formed when it is stated that, directly and indirectly, this company would be able to meet the carrying requirements for heavy goods of over three-quarters of the population of the kingdom—that being about the proportion within reach of inland navigation and the sea-board—would counterbalance the immense development of railway branches and stations, which have stopped many sources of traffic to canals.

A word of warning is necessary when considering the promotion of such a company. Protection against monopoly should be secured by the adoption of low rates of toll, based on a graduated scale of reduction as traffic develops, whilst leaving sufficient inducement to the company to encourage all possible traffic, and give reasonable facilities and fair latitude to bye-boat competition.

Promotion by company-mongers, as also bogus and ill-considered schemes, must be avoided, or confidence of the public will be endangered, and thereby the success of the company also.

There is also a danger, at the present time, in the divided interests which may ensue, if the promoters of the many schemes which are now being formulated (several by parties practically unacquainted with the subject) do not set aside all self-interest and rivalry, and by united action, full, impartial, and careful consideration of all the facts and evidence obtainable, work out the best and most complete scheme, and resolutely carry it through. If several parties press forward separate schemes to suit their particular interests or localities, and make large profits, the result will inevitably be that some will prove failures, and the interests of the nation will suffer through the expenditure of unproductive capital, as well as obstruction to a national scheme. Promoters should guard against well-meaning but ill-informed friends. Most valuable knowledge for the guidance of canal projectors is to be obtained from a careful study of canal and railway history, and the progress of railway development and system of management. They should also rely upon the advice of practical men of canal experience.

The self-interest of such a company would probably lead to the full development of canals, and a reliable competition with railways, provided such a company be established on a broad basis, and not at the mercy of railways by being limited to short length, or one route only. The splendid results attained by company management of railways as regards service is encouraging. No better ordered executive body has ever existed.

Again, to ensure effective competition, the company must be carriers, with complete arrangements, giving regular and quick dispatch. The public have become used to dealing with responsible companies, private carriers could not effectively establish the required confidence, and meet the public requirements on a large scale, certainly not for through traffic. As carriers the company would find out by experience the difficulties of their transit, and improve it. They would also keep more in touch with the public, thereby being induced to meet its requirements. Railways having become carriers, canals must meet their competition by following suit.

Against these, we have the disadvantage of

possible monopoly and collusion with railways, at the cost of the public good.

We may take it that no such scheme is likely to be started by canals which are now paying high dividends, such as the Aire and Calder, and Leeds and Liverpool canals, since their present large profits would be reduced, at least for a time. To myself it appears natural that the origin of such a company as I have outlined should be in the great Midland district, which being farthest inland, most requires it; where the great coal and other mineral deposits would be the backbone of its existence, where the levels are most suitable, and where the present canals are groaning under their difficulties, and would, from self-interest, most probably be willing to amalgamate and further such an undertaking. With the assistance of chambers of commerce, trade associations, and public support, such a scheme could be carried out and worked to a success. A first step in this direction has been taken by the Trent Navigation Company, who last Session obtained powers to improve and render efficient the waterway from Burton-on-Trent to the Humber. The success of this undertaking will be watched with interest by all parties interested in inland navigation. With the commencement of the vast undertaking of the Manchester Ship Canal and the works on the Trent, may we not fairly hope that a new era in inland navigation has commenced? We have already the rivers Thames, Severn, Weaver, Ouse, and Ancholme, as well as the Gloucester and Berkeley and Aire and Calder Navigations, improved for craft of from 150 to 200 tons each.

As the engineering questions of canal improvement and methods of construction have been dealt with elsewhere, I will only say that, viewed from a traffic standpoint, the first object should be to carry out the engineering to suit, and give every facility to the requirements of present and prospective traffic, as railways have so advantageously done; and not leave the traffic management to battle with defective engineering, as is now the case on the old canals. Diversity of gauge and depth must be avoided. It is remarkable that, whilst the evils arising from these were pointed out by Phillips, in his treatise on "The Advantages of Inland Navigation," as early as 1766, when he was working for canal schemes with Brindley, still the great canal engineer perpetrated the great error of instituting two gauges, of 7 ft. and 14 ft. respectively, notwithstanding the very decided advantages which Phillips urged would result if uniformity of gauge had been adopted, capable of passing decked craft of 30 to 40 tons, which could work from the interior canals down the rivers direct to port without transhipping, and so save much time and expense.

For our engineers and contractors canals afford a splendid field of enterprise. There is ample scope for invention and improvement. Every possible means of economy which engineering skill can devise for increased capacity and speed, with its saving of time and labour, by means of long levels, with embankments, tunnels, inclines, lifts, &c., should be effected. When we consider that a reduction of one-half the time in transit would draw at least double the quantity of traffic to canals, as well as save a large per-centage of cost in wages, boat hire, &c., the importance of this is obvious. I may here observe that, so far as I have seen, the engineering sketch as given by that very able engineer, Sir Arthur Cotton, in his invaluable pamphlet on "Internal Transit," appears the most practical, especially as to size of boats, capacity of canals, and effect upon our national prosperity. His valuable experience, too, adds very great weight to his conclusions.

The general ideas, as set forth in Mr. Samuel Lloyd's pamphlet on "National Canals," are very good, and capable of considerable extension. I would like to suggest that, in addition to the trunk lines crossing at Birmingham, another main trunk should be made by the Leicester route from Braunston (the terminus of the Grand Junction), to the great Derbyshire and Nottingham coalfield, through the Erewash Valley, and thence by Chesterfield, Sheffield, Barnsley, to Wakefield and Leeds, whence the great Lancashire and Yorkshire towns would be served through their present canal systems, which would be improved. The latter portion of this would be costly, but, I think, very remunerative. Again, from this trunk, one of equal capacity should commence between Nuneaton and Leicester, striking the great 70-mile canal level of the Ashby, Coventry, and Oxford Canals, pass along the Ashby Canal route by straight cuts, through the North Leicester coalfield, lime, and granite districts to Burton, with its enormous trade of over 1,000,000 tons a year, and thence through the Staffordshire Potteries, where it would join the Liverpool and Manchester Trunk.

Then short cuts (all of which should be of the approved type) would be valuable, such as

that required between Grantham and Sleaford, which would open up the water route from Lynn, Wisbeach, Spalding, and Boston, to the Midlands.

The ordinary trunk routes would probably require a capacity of 4,000,000 or 5,000,000 tons, whilst the Grand Junction length serving for through traffic for the Liverpool, Burton, and Yorkshire lengths, would probably require capacity for 8,000,000 to 10,000,000 tons.

For the support of water transit, good wharfage and warehouse accommodation are essential in all large towns on the route, as also at all places where considerable traffic offers. This should be liberally provided for in the estimates.

Just a word in conclusion, respecting the present "Railway and Canal Traffic Bill." Its fate is as yet unknown. It may considerably assist canal transit, if Lord Jersey's clauses against preferential rates are carried out. Preferential rates on railways largely mean canal coercion, and hence, if they are abolished, and traffic freely allowed to follow its natural channels, it will prove helpful to canals, and not materially hurtful to railways. I am convinced that wherever traffic is unduly diverted by preferential rates, the result is a loss to the companies interested as well as the country generally. Considering how previous "Traffic Bills" have been evaded, and the little effect for good they have had, it is not wise to be too sanguine.

The strengthening of the commission by the addition of a good man of canal experience is good, as also the clauses providing for inspection of canals by Board of Trade, and compulsory notification of stoppages.

But the real point is the tolls, the present classification of which is most absurd, and its anomalies an enormity.

Uniform classification of goods and tolls, together with a thorough revision of legal rates and charges, will alone make the Bill of real value, and in conjunction with improved canals, afford that relief which the national resources now require for their further development.

Mr. H. Thomas (Grand Junction) said that canal was now in a better state than it had been for many years, and strongly objected to Mr. Cotsworth's statement that it was only a muddy ditch.

Mr. Aitken deprecated the discussion being allowed to degenerate into peculiarities with regard to particular canals. To get back to the general question—the Government should, he thought, take over the canals, at valuations based on the present traffic. They should then be widened and deepened equal to a capacity of four ordinary boats, making the locks 160 feet long, and 15 feet wide. Those dimensions would admit of the passage of a steamboat 150 feet long, 14 feet wide, and 4 ft. 6 in. deep. That would be of great advantage for long-distance traffic, such as that between Birmingham and London; smaller boats would be enabled to take traffic on the branches. He would only advocate that the main trunk canals should be made of that size, so that four boats together might come down the canals, or one large one. If one such main trunk line were made from London to Liverpool, and one or two other similar lines in other directions, a great relief would be afforded to the trade of the country. He had been engaged in reporting upon the water communication between Berlin and the ports of Hamburg and Stettin. He became intimately acquainted with the mode of conveyance, and found that the whole of the traffic except tea and fine goods was carried between Hamburg and Berlin in barges or steamers. The navigation was maintained by Government, and the only charge made for any barges was 6s. for lockage; otherwise their passage was as free as that of vehicles along the open streets. Such a system would be very suitable in England, and the railway companies would not be at all injured by it. The fact was that the heavy goods traffic by railway was so competed for that it hardly paid its expenses. When heavy goods were carried by canals industry would be fostered, and a larger population would be enabled to live on the land. He thought when large steel works were found to be removed from Sheffield to Workington on the coast, it was plain there was "something rotten in the State of Denmark." Unless the Government took up the matter, it was impossible that what was necessary could be done. It would be impossible for any private company to take over the canals, and even if that could be done it would be difficult to make them a success.

Mr. Martin Wood said Mr. Cotsworth's paper was very useful in directing public attention to the great subject of inland navigation, and had stated very fairly the pros and cons in regard to the Government acquisition of the waterways. Feeling that public opinion was not yet ripe for so large a department of public works to be undertaken, Mr. Cotsworth had fallen back upon the formation of one big private company. Even that would be better than the present patchy system; but still it would be setting up a sort of *imperium in imperio* in our commercial affairs which would be simply intolerable. On the other hand, he should like to remark on the course taken by some speakers who advocated State acquisition of waterways. It was assumed that if the Government took possession of the canals therefore there should be no tolls, and that the traffic should be carried free; but there was no need to make such an assumption, and so make the question

impracticable. The public did not expect letters to be carried free, and were quite content that the Government should make a profit out of the Post-office. Of course the cost on traffic would be reduced to a minimum, because there would be no desire to make profits. That would be the result of a properly managed State department of through waterways and inland navigation. He quite admitted that, under present circumstances, we were not yet in a position for that to be done, but it was high time we should set about it as it was a thing which really could be done in the near future. We must try to get out of our old-fashioned ideas that everything should be done by private enterprise, because in this case the possible result would be to strangle the commercial interests of the country.

Mr. C. F. CLARK (Wolverhampton) protested against the assumption that it would be unjust to shareholders that Government should take possession of the canals; on the contrary, it would be an act of great justice to them. At any rate the railway shareholders would by that means be able to carry their coal traffic, which now was taken at ½d. per ton per mile on the improved canals, and so greatly relieve their rails, and enable them better to develop that passenger traffic which they carried at 2s. per ton per mile. Surely that would pay them better than keeping the coal and mineral traffic at ½d per mile. Again, it was suggested, apparently that the canal trusts must themselves of necessity be carriers. He protested against that idea. If canals were improved, being highways for everybody, the railway companies would be the first people to use them, by putting their heavy traffic upon the canals in order to relieve their now congested lines in consequence of working three services at three different rates of speed on the same rails.

Mr. T. BANTOCK (Wolverhampton) remarked that the country would at the present day be almost a desert were it not for the railways; but canals were the means of distributing to and from them. No doubt both were now working together in a form which was exceptional, but it was not the fact that railways were at all an injury to the canal in Staffordshire; on the contrary, they were the means by which the manufacturers of that part of the country were at present in so flourishing a condition, notwithstanding that the minerals had to be imported largely into the district, imported, as they were, chiefly by railway. He spoke from knowledge during the whole period that the change had been going on. South Staffordshire produced, in 1849, 1,000,000 tons of pig-iron. That quantity had become reduced as low as 250,000 tons per annum, and how had the manufacturing industry in iron been kept up without decreasing? Simply and solely by the great additional power which was given by the formation of railways. Millions of tons of additional mineral traffic had come into the district, and had so enabled them to manufacture from the pig-iron produced in other districts the goods which were the basis of the prosperity of the district.

Mr. SHELFORD said Mr. Cotsworth seemed to think the best solution of the difficulty, from a national point of view, would be that the Government should purchase the canals and work them.

Mr. COTSWORTH said, on the contrary, he had suggested that the Government should not work them.

Mr. SHELFORD said in that case the recommendations to that effect should be expunged from the paper. If, on the other hand, they were to stand, it should be recognised that the Government should work them for the public advantage. The function of Government here, as in the United States, in France, in Germany, and in Canada, should be to provide good waterways for the traders of the country.

Mr. J. H. TAUNTON, referring to the happy condition of Staffordshire as described, inquired whether it had not arisen from the canals being in the hands of, and made to serve, the railway interest?

Mr. BANTOCK said it arose from the facts he had mentioned. The canal was the most available means of bringing the local traffic from the mines to the works where it was consumed by the manufacturers. In reference to the canal being in the hands of the North-Western Railway Company, having known the district as a carrier since 1849, he could testify to the fact which Mr. Jebb had stated, that the canal was in a better condition to-day than it was between 1849 and 1856, in a very much better condition, although the Railway Company was losing at the rate of £30,000 a year in maintaining the dividend which it was paying.

Mr. TAUNTON had no doubt that the canal was well-maintained under Mr. Jebb's jurisdiction; but with regard to the loss of £30,000 a year, was not that more than covered by the increased rates which the railway company obtained?

Mr. LEICESTER (North Staffordshire) asked how it was that the Birmingham Canal had lost £30,000? There must be something beneath the surface which would explain that.

Mr. BANTOCK said it had been proved by evidence, over and over again, that the canal companies and the public were themselves to blame for the position they were in; for rather than consent to the railway companies coming into the districts they had pressed forward claims of "vested interests," and so had forced their purchase by the Railway Companies, so that they might receive interest upon canal capital. That line of conduct was of course very unwise, and Parliament had said that it should not be continued; but the evil had been done long ago

and could not be undone except by legislation which would put the canals on their own legs and let them stand separately. And he felt sure that the railway companies would only be too thankful to get rid of the burden of the canals.

Mr. E. J. LLOYD said the assertion that the Birmingham Canal was losing £30,000 a year was incorrect; in fact it was at the present moment realising a profit of £100,000 a year by its working. The guarantee, inclusive of interest, being £146,700 per annum, and the loss to the guarantors the difference between these amounts. A large traffic had been spoken of as being confined to that canal and district alone; but the natural and proper position of the canal was that of a great gathering medium for products conveyed to the out-ports. He represented two canals, with a capital of £250,000, and it was a fact that, down to the present time, their traffic had paid in compensation tolls to the Birmingham Canal, the Great Western, and one other company more than a million of money. To take the case of the Great Western Railway, that company owned seven canals; they spent a million of money upon them; and the result of their working last year was that one of those canals earned £2,700 profit, and the remaining six lost £1,300, besides the whole of the interest upon their capital. What was necessary for the resumption of canal traffic was mileage rates enforced over every railway-owned canal in England. If that were done—if every railway company were compelled to take its fair share and no more of a through rate, and if compensation of every form and description were abolished, the canals could hold their own.

Colonel HAMILTON asked what was the daily or yearly carrying capacity of a canal, such as one of those two lines of canal which had been proposed, having locks 14 feet wide and 7 feet deep, whether taken in narrow boats of 8 feet beam, or in wide boats.

Mr. COTSWORTH, in reply, said he did not think the capacity of any canal had been fully reached. On any given route of 30 feet wide, or any other measurement, provided barges could pass each other freely along the canal, and the locks were duplicated, the traffic could be doubled. He did not think that at present there were any data showing what the capacity would be, but it was practically unlimited with proper locks. With comparatively slight improvements, he believed that some of the canals could be made of a capacity to suit 3,000,000 or 4,000,000 tons a year. He had not attacked either the Birmingham or Grand Junction Canals specially, but had merely pointed them out as having been two extremely prosperous canals formerly, and then he inquired why they had not retained their position. He was supposed to have suggested that the Government should undertake the working and management of the canals—what he had referred to was the management, maintenance, working of the locks, and so on—not the working of the boats, tugs, and traffic arrangements.

The CHAIRMAN proposed a vote of thanks to Mr. Lloyd and Mr. Cotsworth for their valuable papers, raising prominently as they did the question how the the canals throughout the country should be dealt with at the present juncture. They would all agree, whether they were in favour of Government purchase or of the canals being worked by private companies, that, at all events at the present time, the canals were not doing for the nation the work they were originally intended to do. This discussion would clear the ground, and enable people to thoroughly consider this very important question. It was not a question which could be settled at one meeting, or in one day, or in many days, but it would, by these means, be ventilated, at a time when it would receive a good deal of consideration from members of Parliament and others.

The Conference was then adjourned to the following day.

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 29.—"Persian Textiles." By CECIL SMITH.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 28 ... Royal Institution, Albemarle-street, W., 9 p.m. Royal Society Croonian Lecture, by Prof. W. Kühne.
Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. L. T. Wright, "Coal Gas Industry."
British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, MAY 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. C. Smith, "Persian Textiles."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "Conventionality in Art."
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.
Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 30...Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, MAY 31...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. L. Fagan, "Wood Engraving."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. T. G. Bonney, "Growth of the Alps."
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Prof. S. P. Thompson, "Influence Machine from 1788 to 1888."

FRIDAY, JUNE 1...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. J. A. Ewing, "Earthquakes."
Geologists' Association, University College, W.C., 8 p.m. Mr. J. G. Goodchild, "Gypsum."
Philological, University College, W.C., 8 p.m.

SATURDAY, JUNE 2...Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Count Tolstoi."

Journal of the Society of Arts.

No. 1,854. Vol. XXXVI.

FRIDAY, JUNE 1, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, June 20th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

The cards of invitation will be issued shortly.

MAP OF ENGLISH CANALS.

With the present number of the *Journal* is issued, as a supplement, a map of the canals of England, intended to illustrate the papers read at the Conference on Canals and Inland Navigation, now being published in the *Journal.*

APPLIED ART SECTION.

Tuesday, May 29, 1888, Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., in the chair. The paper read was on "Persian Art." By Cecil Smith.

A report of the meeting will be published in the next number of the *Journal.*

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen, in certain classes of art-workmanship, under the following conditions:—

1. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

(i.) Copies of existing works.

(ii.) Modifications of existing works.

(iii.) Original works.

It should always be stated under which heading (i.), (ii.), or (iii.), the objects are to be entered.

4. In awarding the prizes, the judges will take into account the following points:— 1. Originality or beauty of design. 2. Fitness of treatment. 3. Excellence of workmanship.

5. Designs or working drawings will not be received in competition.

6. Before the award of prizes is finally made, the candidates must be prepared, if called upon, to satisfy the Council of their competency.

7. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

8. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for accident or damage of any kind.

9. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

10. All the prizes are open to male and female competitors on equal terms.

11. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

12. All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope, giving the name and

address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House or, if the necessary arrangements can be made, at the South Kensington Museum.

13. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges. Certificates will be given to the winners of prizes.

The following are the classes in which prizes are offered for the Session 1888-9:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5; second prize, £2.
   b. Shaved or turned, first prize, £5; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.
   c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for outside a window, a street-door panel, or for inside as a window screen, or for coil case, ventilator, &c.

Proceedings of the Society.

CANAL CONFERENCE.

Friday, May 11th, 1888. Sir Douglas Galton, K.C.B., F.R.S., Chairman of Council, in the chair, followed by Col. A. C. Hamilton, R.E., Member of the Council.

INLAND TRANSPORT IN THE NINETEENTH CENTURY BY LAND AND BY WATER.

By Francis Roubiliac Conder, M.Inst.C.E.

Sixty years ago, mechanical workmanship in England had few of those exact and powerful appliances with which the workshops now abound. Fairbairn, and Nasmyth, and Whitworth had not perfected their machine-making tools. In his application of the great invention of James Watt to the movement of load by land, George Stephenson had to rely very much on his own thoroughness as a workman. In the memorable competition of October, 1829, when the iron horse first developed a portentous and unexpected speed, it was due to the sound Northumbrian workmanship that the "Novelty" of Ericsson was beaten by the "Rocket" of Stephenson, which the former left far behind in the race, until the inferior ironwork gave way. A prodigious impetus was then given to English workmanship; and the great mechanical progress which waited on the cradle of the locomotive was attributable, in no small degree, to the practical knowledge of the Stephensons. The lead thus taken by England was long maintained. In 1853, when railways had been for twenty-two years introduced into France, the rails of the French makers were so irregular that no two were exactly equal in length; and they would often crack like a nut under the weight of the heavy locomotives built by Messrs. Gouin. The extraordinary success of the passenger traffic (which was little more than accidental, as far as the project of the Liverpool and Manchester Railway was concerned), accelerated the industrial revolution. The London and Birmingham Railway returned 10 per cent. dividend to its hardy and confident shareholders; and solid substantial success led to that railway mania of 1845, from the mischief done by which this great industry has never fully recovered.

Amongst the few persons who anticipated that the new mode of communication might prove ruinous to those who had lived on, and by, the older lines of land and water transit, were the proprietors of the canals. They opposed the railway companies stoutly; on standing orders, in committees, on each occasion of the reading of a Bill in either House. They obtained, as a rule, little more than provisions for the regulation of headway and waterway, and penalties in case of interruption of traffic. But the railway companies were not slow to retaliate when they had obtained their Acts of Incorporation. They coveted the traffic of the canals. They did not stop to calculate the difference of cost between land and water transport. They were blind to the fact that, as the passenger traffic had deserted the highways for the rail, so soon as the latter was open, so would any traffic that they could afford to convey as cheaply as the canals, and at greater speed, fall at once into their hands, if they left matters to take their natural course. The force that will draw a load on a canal at four miles an hour is just half that required to draw an equal load on a railway at thirty-five miles an hour. The other items of working cost, the maintenance of works and of way, the repairs of vehicles, and the expenses of watching the line and conducting the traffic, are nearly five times as much by land as by water for an equal load. The outlay of capital requisite for providing for a given amount of traffic is more than tenfold by the railway as compared to canal. On these main conditions, had fair play been allowed, the inland traffic of England would have sorted itself. That which could afford to pay a three-fold rate for speed would, like the passengers, have spontaneously sought railway transport. That which could not afford to pay a freight of which fifty per cent. was profit would have continued to go by water, to the great pecuniary advantage of the freighters, of the canal owners, and of the railway owners.

Unfortunately this genuine freedom of trade was strangled by the railway managers. They had no idea of the physical limits of capacity for transport of either a single or a double track of rails. They thought, very erroneously, that they could carry all the trade that they could get, and that it would be better to carry a large quantity of heavy traffic at a low profit than not to carry it at all. In this, as mathematics would have shown them, they were wrong, and the error has never been retrieved. Parliament was utterly idle as a controlling power in the matter; the Government did not make it their duty to study it; and "the railway companies were able, in some cases by means of questionable legality, to obtain command of 1,717 miles of canal, so adroitly selected as to strangle the whole of the inland water traffic, which has thus been forced on the railways, to the great interruption of their legitimate and lucrative trade."

The canals, no doubt, were ruined by the abstraction of their natural traffic. But the theft was twice cursed; it ruined those who took as well as those who lost. Railway proprietors were very slow to perceive—many of them have not at this moment perceived—that the vast sums which they were annually called upon to spend on the improvement of their property did indeed extend it, but did not improve it in the way of net earning. From 1854 (when returns are first accessible) to 1885, the railway proprietors of the United Kingdom, besides more than doubling the mileage (raising it from 8,000 to 19,000 miles), added one-fifth to the cost of each mile (raising it from £35,000 to £42,500). Within the same period of time they increased their mileage revenue by 44 per cent. But in spite of this outlay and this increase, the property was not much more remunerative; the net per-centage on capital was substantially the same. Of the large increase of traffic, so much was non-remunerative as to raise the working expenses of the whole to a proportion that forbade any increase of profit on capital. In the prosperous times of 1844-5, 60 per cent. of the gross revenues of the railways were derived from passenger traffic; the remaining 36 per cent. was earned by goods traffic carried at corresponding rates of charge; and the net profit was 10 per cent. on the capital. In 1885, 22 per cent. of the revenue was derived from a very low-rated mineral traffic; the passenger income was under 43 per cent. of the whole; the working charges had risen to 53 per cent. of revenue; and the poor return of a little over 4 per cent. on capital was the natural result.

While England has been thus crippling her industrial power by wasting money on a costly and non-remunerative mode of carrying a heavy traffic, by land instead of by water, the Continental nations have been busy in learning from her experience, and in improving their productive power by her aid. The only comprehensive account we have of the *régime* of public works in England is one written in

French, by a Frenchman, for the guidance of the French Government and capitalists. Our newest and best machinery, our excellent and limited supply of coal, our able engineers and contractors, were placed at the service of our Continental competitors, to be treated, at least as far as the individuals are concerned, like the skin of an orange when the pulp has been extracted. France, Germany, and Italy rapidly pressed on us in the race; they learned all that we had to teach, and they added to this knowledge the results of their own careful study and experience, which we neglected. Thus the relative position of the United Kingdom towards the rest of the civilised world has been swiftly and steadily altering for more than the lifetime of a generation. Forty years ago the United Kingdom was the first producing power in the world. She owed her primacy in part to her mineral wealth, in part to her maritime supremacy, her hardy seamanship, and the accessibility of her ports, harbours, and navigable rivers, but first and foremost to her workmen. The British workman was the best fed workman in Europe, and for any work which required at the same time strength and skill was without a rival. This is not mere idle brag. Careful observations have been made, by the writer as well as by others, of work capable of being exactly measured, with the result that in equal times the British workman did more than twice as much work as picked French workmen, both in the south and in the north of France. But the introduction of steam machinery has tended very much to destroy this superiority. A man of inferior physical strength can watch a lathe, a steam-hammer, a planing-machine, or a saw-bench, nearly as advantageously as a Hercules or a Vulcan. When to the equalisation thus approached (per man) are added the long hours for which the Continental workmen are accustomed to work, it is easy to see that almost every product of the forge or of the factory is now obtained more cheaply in France, in Belgium, and in other countries than in England. It is difficult to mention any important article of consumption that cannot now be produced cheaper abroad than at home, and sent by sea to our centres of production for less money than it would cost to carry it across England by railway.

It is thus incontestable that it is a matter of supreme national importance that the question of inland transport should be clearly understood. The feeble and unsatisfactory attempts that have been repeatedly made within the last few years to amend railway legislation in England, and to mediate in the quarrel between the railway companies and the railway freighters, have naturally and deservedly failed, because they were not based on any accurate knowledge of the subject. While one party has been anxious to obtain a reduction, and the other party an increase, of rates, the administration has been unable to exert any intelligent influence on the debate, from its total ignorance as to how much any particular class of traffic actually costs. How easily and how thoroughly that knowledge may be attained has been shown us, ten years ago, by Mr. Rae, the Commissioner of Railways in New South Wales, and by his successor, Mr. Goodchap. And in December last, Sir Juland Danvers brought before the Statistical Society the fruit of his long experience on Indian lines, telling the same tale. An enormous mass of information has been collected, chiefly from foreign and colonial sources; but it has hitherto been disregarded alike by the English railway managers, by the proprietors, by the public, and by the Government.

While matters have been allowed thus to drift in the United Kingdom, the statesmen and engineers of other countries have patiently ascertained the controlling laws which regulate inland transport, and both enterprise and legislation have been advantageously modified in consequence. Analytic inquiries in France, Germany, Italy, Belgium, Austria, Holland, and elsewhere, have independently ascertained the true cost of the transport of different classes of traffic, by rail, canal, river, and sea. The French Government, and Chambers, adequately informed by the clear-sighted engineers of the *Ponts et Chaussées*, have long ago exploded the idea that there is room for any real rivalry between railways and canals. "Each of these two ways of communication," reported M. de Berigny to the Chamber of Deputies, in 1833, "has its distinct and special domain." "Nothing," remarks M. Picard, the author of the admirable book, "*Les Chemins de fer de France*," in 1884, "is to-day more true. Almost everywhere that navigable routes and railways run side by side, the development of industry and commerce has been such that, after a brief crisis, the traffic of the older line of communication has notably increased. Far from being enemies, railways and canals aid one another in the performance of their natural duties. The former transport passengers, costly merchandise, manufactured products;

all that cannot endure long delay; the latter, on the other hand, transport raw materials of small value, for the transport of which speed is of secondary importance, which cannot bear high rates of charge, and which in consequence do not form a remunerative traffic for railways." "The delay of a week or a fortnight in the delivery of these articles," reported the Commission named by the Chamber of Deputies, in 1878, to examine the project for improving the inland navigation of France, "is a matter of little importance, while the difference of freight, for long distances, between the lowest rate at which a railway can carry and that which is attainable on a canal is equal to half the price of the goods." "Coal," the Commission stated, "cannot be carried on railways, even for long distances, at a less cost than from 0·54d. to 0·62d. per ton per mile, but can be transported by canal for 0·22d. per ton per mile." "In France, in Germany, in Belgium, and in England," says the *Edinburgh Review* for October, 1882, "the round price of one-third of a penny per ton per mile will pay for transport on canals of adequate section and volume of traffic, and this price includes, not only a fair interest on the capital, but also provision for a sinking fund, which within a determinable time, will render these inland water-ways the property of the nation, to be used free of charge, except the trifling amount necessary for maintenance of the works and attendance on the locks. On a traffic of 600,000 tons per annum, this charge does not exceed 0·022d. per ton per mile." The cost of towing, to be borne by the users of these national water ways, has been found to be as low as from 0·065d. to 0·079d. per ton per mile for horse towing in Belgium, including the return of empty boats.

"In order to obtain the mean return of 4¼ per cent. on capital, which is all that the English railways have secured since they stopped the canal traffic, the normal charge must be, for passengers 0·67d. each, for goods 1·164d., and for minerals 0·838d. per ton, per mile."* The charge at which the long coal traffic is conveyed to London from Wales, over the Great Western Railway, is 0·43d. per ton per mile; the loss to the Company being to some extent recouped by charges of from 1·5d. to 1·75d. per ton per mile made to those towns which have no alternative means of supply. The positive loss to the Company is thus about 0·4d. per ton per mile, and about half that loss is inflicted on the purchasers or freighters. In determining the total loss inflicted on the latter, however, it is necessary to compare the length of the competing lines of water transport.

While it is the carriage of minerals at non-remunerative rates that chiefly reduces the dividend of the railway proprietor, it is the high cost of transport of both raw material and finished goods of heavy nature that chiefly burdens the manufacturer. Session after Session has seen the introduction of a Railway Rates Bill, framed with the sanguine hope of establishing a *modus vivendi* between the companies and their customers. These Bills have all failed, and that for two very sufficient reasons. First, the companies are everywhere driven, owing to the loss they have inflicted on themselves by carrying so much non-remunerative traffic, to charge the utmost possible for the transport of goods, and they now seek to enlarge their powers of so charging. Secondly, neither the companies, the freighters, nor the Government have any clear idea of the actual cost of the conveyance of any distinct kind of traffic, and all are thus entirely unable to recommend any intelligent principle of compromise. Under these circumstances some of our most important productive industries are migrating from their inland cradles to the shores of the Clyde, the Usk, and other navigable rivers in our own country, and even to those of the Bilbao River and of the Bay of Naples. Steel works, iron factories, cotton works, the manufacture of artillery, the leather trade—are moving, or on the move. The question of inland transport bids fair, if neglected, to settle itself, and that in the most unsatisfactory way possible, namely, by coming to a close, owing to the migration of the great factories to the seaboard, or to spots easily accessible by water from the sea.

It can not be too clearly shown that the question of the capacity of a line of route for traffic is one of a cardinal nature, which has hitherto been generally neglected in this country. It may be admitted, at all events for the sake of argument, that even the low-priced long mineral traffic may show a profit (on paper) of 5 or 10 per cent., by comparing the mileage receipts with the running expenditure. But the question of occupation of the line is one of a more serious character. Increase of speed demands increase of fuel, in proportion to the increase of atmospheric resistance to be overcome. It is matter of debate whether it really adds in any other respect to working cost. But decrease of speed involves increase in wages, and in all

* Mr. Conder's Report on Wilts nd Berks Canal, 1882.

other charges that are paid according to time. There is thus, on every line of public accommodation, a normal economic speed, at which the sum of the charges for fuel and for wages amounts to a minimum. As we travel faster than this rate the cost of fuel increases more rapidly than that of wages diminishes. As we travel slower, the reverse is the case. In every case the proportions may vary, but over the English railways, on the average, the most economic speed is generally a little over thirty miles per hour.

It is thus evident that in decreasing the speed of the heavy mineral trains, in order to save fuel, the railway managers have been unwittingly increasing those costs which depend on time. Nor is it only the wages of the drivers and guards of the heavy trains which have to be taken into account. There remains the much more serious question of the occupation of the line. The train which travels half as fast as the most economical speed demands a double amount of service, measured by time, from all the signal men, station men, and generally from the stationary staff of the company.

This is the case to a certain extent, if we compare two lines—such, for example, as the Taff Vale and the Metropolitan, running at different rates of speed. The loss is minimised when the trains follow one another at equal distances, and at equal rates of running; and the main loss of wages incurred by going slowly in such cases is that of the moving staff. But the case is entirely altered the moment that two rates—still more three rates—of speed are introduced on the same track. Complex, costly, and dangerous arrangements are now made in order to allow the quick trains to run by the slow ones at particular stations. But if we take the case of a single section of line without crossing places, the loss of the capacity of the rails for traffic is exactly measured by the difference of the rates of speed allowed. If we take fifteen minutes as a safe interval of time to allow between two trains, four trains an hour may follow one another, with equal regularity, at speeds of ten, of twenty, or of thirty miles an hour. But if one train runs at ten, and another at twenty miles an hour, over a ten-mile length, only two, instead of four, trains can be dispatched within the hour.

This disadvantage of a rigid line of track is not shared by canals, where passing is at any point possible, and where capacity is only limited by the occurrence of locks. The subject has not received due attention. But it will be seen that this interference of trains is the true cause of the heavy loss incurred by the main trunk lines from the carriage of minerals at a low profit over working cost.

There is thus a plain mathematical reason for the economy which the French engineers have practically found to attend on the provision of a double line of service (by land for speed, by water for cheapness), which cannot be evaded. The very fact of the low rate of speed at which, all over the world, the heavy mineral trains are accustomed to travel, shows that the railway managers are instinctively aware that it is too costly to transport heavy loads of low priced materials at the true railway speed. The proper inference is that such loads should not be transported by a costly service, which finds its chief economy in its great speed. And though cases may and do exist where mineral lines, pure and simple, properly constructed for their especial duties, carry a remunerative traffic, the transfer of that proper water freight on to a line of mixed traffic is a ruinous blunder.

Birmingham, Manchester, Leeds, and most of the great inland centres of industrial production, cradled their prosperity in the use of inland waterways. On the introduction of the railway system, the convenience afforded by the speedy transport, and the obstruction thrown in the way of the canals, transferred a large amount of heavy traffic to the railways, which then carried it at a lower charge than at present. Neither the manufacturers nor the railway managers had the gift of prescience. The first did not anticipate a close contest with the foreigner in the art of production; the second did not understand the law that limits the capacity of their lines for transport. But, meantime, in France, Belgium, Holland, Germany, and elsewhere, the manufacturers, while availing themselves, as before shown, of the experience and the science of England, steadily maintained and improved their inland water routes. They thus assured an additional source of economy in aid of their long hours of work and low wages. French and Belgian statesmen clearly pointed out the trade advantages that would accrue from the limited term for which railway concessions were granted, and from the application of the resources of the State to the improvement of the waterways. What they foretold has come to pass. So serious is the burden imposed on trade by the cost of land carriage of raw and very heavy materials, that some of the chief industrial

establishments of England have already, at a vast sacrifice of capital, abandoned their inland seats, and erected new factories where water carriage is available. The steel works of Dronfield, and the screw-making and other factories of Messrs. Nettlefold, were among the first to move; but the migration has now assumed alarming proportions, and, as far as it is safe to attempt a forecast of the future, it looks as if the prosperity, if not the very existence, of great inland centres of production must depend on their recovering the advantages of water transit.

England, though not the first country to make canals, is well adapted for inland water-carriage; and certainly based a century of prosperity on the construction and use of canals and navigation. Four principal systems of waterways were formed, to link together the important estuaries of the Thames, the Mersey, the Humber, and the Severn, with branches to connect the chief inland towns with these seaport termini. Connecting the Thames with the Mersey and the Severn, there exist some 650 miles of inland waterway, 200 miles of which have passed under the control of railway companies. The cost of this group of canals is not more than £5,000 per mile, and tolls and dues are authorised by Parliament for the maintenance of the river navigations.

Nearly 400 miles of canal, and 140 miles of river navigation, form a network between the Thames and the Humber. A hundred and seventy-five miles of this system have been grasped by the railway companies. The cost of these canals has been close upon £10,000 a mile, and the freeing them from obstruction, and the improvement of the system, would be of extraordinary benefit to the country which they were constructed to serve.

Six hundred miles of canal, and 230 miles of river navigation, have been constructed to serve the great industrial district between the Severn and the Mersey. Of these, in 1882, only 110 miles of canal remained in the hands of independent companies. The average cost of the canals of this group has been £9,000 per mile. The convenience formerly afforded to Birmingham and other manufacturing towns by the system was one of the utmost value. The Birmingham Canal was one of the most useful public works ever executed in England. Together with the Shropshire Union, and four smaller canals — making a total mileage of 459 miles—it has passed under the control of the railway companies, and is now used to block, by its disproportionately high charges, the connection of the Staffordshire districts with the maritime outlets. An attempt has been recently made to re-open the communication with the mouth of the Severn by the improvement of the Worcester and Birmingham and the Gloucester and Berkeley canals. Another scheme is announced for a waterway to the great river outlet of the Trent, one of the most admirable channels of inland water traffic, if properly maintained, in the kingdom. There is much reason to conclude that the future of Birmingham must in a great degree depend on the opening of one, or, better, of two lines of cheap transport.

Six hundred and eighty miles of waterway, of which 415 are canals, connect the Severn and the Mersey with the Humber. Of this, no less than 360 miles of canal have been appropriated by the railway companies. The statistical returns made to Parliament by this group of canals are extremely imperfect. The Leeds and Liverpool Canal, which has never ceased to be a well-paying as well as a most useful line, has, however, been rescued from the Lancashire and Yorkshire Railway Company. In this district lies the famous Bridgewater Canal, that great work of Brindley which, by supplying Manchester with cheap coal, raised the fortunes at once of the metropolis of cotton and of the ducal house of Bridgewater. In this district, after an unparalleled contest, Manchester has at length obtained Parliamentary sanction to opening her way to the sea, and the great Manchester Ship Canal is now in course of construction.

The four great estuaries, which are thus connected by nearly 2,700 miles of waterway, are also linked together by seven great railway systems; the aggregate length of which, in 1882, was about 7,400 miles, and the aggregate capital nearly £350,000,000 sterling. The aggregate gross revenue, in the year in question was over £34,000,000, of which the net revenue was about 46 per cent., or under £16,000,000 sterling. Of this gross revenue, $7\frac{1}{3}$ millions was derived from mineral traffic, which the warmest advocates would hardly assert to bring in more than 10 per cent. of profit over actual working expenses. The carriage of this mineral load formed 40 per cent. of the total work done on the lines in question, and occupied the lines and stations for more than half the entire working time. Of the total capital cost of £47,000 a mile, at least £18,000 a mile may thus fairly be assigned to

providing for the mineral traffic, or, at all events, for the contemporaneous carriage of three very different descriptions of traffic over the same tracks.

If we suppose the mineral traffic to cease to run, we should reduce the total income to 26·7 million, and the total working expenses to 11·7 millions, showing a net profit of £733,000 less than the present earning. But this profit, had not the capital amount been so unduly swollen to provide for the accommodation of a heterogeneous traffic, would have been divided over a capital of £29,000 a mile, on which it would have paid a dividend of 7·3 per cent. It may be said that, as the larger mileage price of £47,000 has been actually paid, there would be a diminution of dividend from the stoppage of the traffic. Allowing that, on the figures assumed, this would be the case in the first instance, it would be but a slight price to pay for a permanent benefit. If the increment of passenger and goods traffic, which for the decade before these figures were taken had been at the rate of from 2¾ to 3 per cent. per annum, continued, the deficit would be filled up in less than two years, and an addition of above £200,000 in each succeeding year would be made to the net profits, while the outlay of additional capital would be almost entirely arrested. The 4·5 per cent. dividend of 1882 would have risen to 5·5 per cent. in 1892, with every prospect of steady increase; as the removal of 40 per cent. of traffic earning (on the hypothesis) 10 per cent. profit, would make room for a very much larger bulk of traffic earning 50 per cent. profit, in consequence of the increase of the capacity of the lines to carry a more homogenous traffic at the true economic speed.

For those who wish to skip the figures, it may be enough to say that the discontinuance of a given quantity of slow traffic, earning 10 per cent. over working expenses, would make room for the conduct of a very much larger quantity of quick traffic, earning over 50 per cent. of profit.

It is not, however, to be thought that the mere removal of the artificial obstruction thrown in the way of canal transport by the railway companies would suffice to bring back at once any very large portion of traffic to its natural route. The scientific world moves; the appliances of 1832 are not adequate to supply the wants of 1888. Our existing canals were designed and made as local conveniences. To unite them in a national system is an object requiring both study and cost. The evidence before the Select Committee on Canals shows how disastrously different are the dimensions of the locks on canals that form part of one thorough line of water way. The loss thus incurred, if the subject is considered, will appear to be very serious. A boat must be small enough to pass the smallest lock; and the waste of water, as well as of capital, involved by its passage through the larger locks is thus very great. For any reintegration of our canal system worthy of the name, we must follow the line indicated by the French Government and Chambers. I do not say we should adopt, without careful study, the dimensions now imposed on the French canals, but I do say that normal dimensions must be rendered imperative in order to make the best of our water-ways. The first point to determine is the size of the boat, as to which it is, perhaps, better not to express a hasty opinion. This fixed, the dimensions of the locks and the cross-sections of the canals must be arranged to fit, bearing in mind that it is necessary to determine the speed that it is intended to maintain, before fixing the depth of the water-way, as speed and depth are closely co-related. Four miles an hour, according to Mr. Lloyd, are now attained under favourable conditions. Seven miles an hour are made on the Royal Canal in Ireland. The question is one dependent for solution on the cross-section of the canal, the cross-section and length of the boat, and the means of propulsion. It depends not only on the area of the cross-section but also on its form, as was shown in the discussion on "Speed on Canals," at the Institution of Civil Engineers, on February 6, 1884. And, with the view (which is ever present to the engineer) of mechanical improvement, the question of walling the sides of the canals, if any increase of speed is contemplated, is one that will press for solution.

The legislation of 1878, which provided for the expenditure by the State of £40,000,000 on the improvement of the internal navigation of France, determined the dimensions of the canal locks at 126·2 feet in length, 17 feet in clear width, and 6·56 feet of water on the sill of the lock-gate. These dimensions are calculated to allow of the use of boats of 120 tons burden. The nearest approach to these dimensions in England, on canals (as distinguished from river navigations, and excepting the Gloucester and Berkeley Canal) are to be found on the 135 miles of the

Grand Junction, where the locks are 87 ft. 6 in. long, 15 ft. in the clear, and with a depth of 5 ft., allowing the passage of an 80 ton boat. The cost of this canal has been calculated at about £9,000 per mile, against £12,000 per mile for a waterway practicable for a 120 ton boat. In either case the addition of 1 ft., or 1 ft. 6 in., to the depth of the canal would make so material a diminution in the resistance offered to transit, and thus save either in speed or in cost of towing, as to render the further outlay of capital to assure it a lucrative investment of money. On the Grand Union Canal, which is, topographically speaking, a prolongation of the Grand Junction, the locks are only 78 ft. by 7 ft. 2 in., which is an example of the obstruction caused by want of unity of system.

The loss of time due to the passage of locks arises from two causes, one of which it is easy to calculate, while the other varies extremely according to the management of the line, and the nature and volume of the traffic. The rise or fall of the water in the lock occupies an ascertainable time, ranging from three to six minutes; but the time lost in entering and leaving the locks is less easy to calculate. With perfect arrangement the loss is very small; frequently it is, in fact, very considerable. In the event of a heavy traffic being thrown on our canals, it will probably be advisable to double the locks, a communication being made practicable between the pair, in order to save half a lock full of water at each passage. With this arrangement much time as well as much water may be saved. The average retardation due to the hydraulic requirements alone of the locks on the English canals is from $1\frac{3}{4}$ to 2 minutes per mile, the average rise to be overcome being under 6 feet per mile of canal.

A feature of prime importance, in which the economy of transport by canal differs from that by railway, is the incidence of the expenses of maintenance. The cost of railway maintenance, as soon as anything like an adequate amount of traffic is brought on a line, is remarkably steady, rising and falling, to a certain extent, with the increase or diminution of the volume of transport. On canals, the fixed expenses demand, in any case, a certain cost, and this cost is very little increased by a large increase of traffic. The annual cost of maintenance in the Suez Canal was actually less from 1876 to 1881 than it had been from 1871 to 1876. But the traffic had considerably more than doubled, so that the cost of maintenance per ton per mile fell from 0·35d. to 0·134d., falling again to 0·088d. in 1882-83.

Bearing in mind this peculiar feature of water traffic, it is necessary, in speaking of the cost of transport by canal, to indicate the approximate amount of transport for which the calculation is made. A traffic of 600,000 units of net load may be taken for this purpose, though it is far beneath the capacity of a canal of very moderate size. At this amount of duty, in order to allow a dividend of $4\frac{1}{4}$ per cent. on the capital cost, the rate of freight on an ordinary English canal comes to £154 per 100,000 units, or 0·37d. per ton per mile. On the French canals, providing for sinking fund as well as interest, the cost of freight is 0·33d. per ton per mile. In Belgium it is reduced to 0·20d., and on the lake and large canal navigations of the United States to 0·10d. But on the Aire and Calder Canal, where very special arrangements have been made for the transport of coal, it was stated in evidence before the Select Committee on Canals, that the cost of freight has been reduced to the very low figure of 0·05d. per ton per mile. This contrasts with the prices (still allowing $4\frac{1}{4}$ per cent. interest) of 0·88d. per ton per mile for coal on the Taff Vale, and 0·75d. on the Maryport and Carlisle, railways, and with my previous calculations of 0·838d. per ton per mile for minerals.

A careful analysis of the railway accounts of 1879 showed a mean transport of 2,144,000 tons of loaded train per mile, which was carried by 20 daily passenger trains, averaging 84 tons in weight, and by 20 mineral and goods trains of 250 tons each in weight. The gross revenue was £3,488, and the net revenue £1,634, per mile. If the 1,100 tons of minerals, the daily carriage of which goes to make up these figures, were replaced by an equal weight of goods, the net profit would be raised to £2,700 per mile. But this increase would far from approach the limit of capacity of the lines for homogeneous traffic. It could be conveyed by 42 trains in the 24 hours, or less than one train in each direction for every hour of the day, exclusive of the night. No practical difficulty could attend the running of twice that number of trains, while the small number of 42 would be equivalent to a gross earning of 11·8 per cent., and to a net earning of 6·7 per cent., on the capital cost of £40,000 per mile. These results, which may be verified from the railway returns, indicate very plainly the direction in which railway shareholders

have to look for the improvement of their property; and the fact of the limitation of capacity for traffic by the concurrent use of different speeds, explains the difficult problem of the constant increase of railway capital cost per mile without any corresponding improvement in the rate of net profit obtained.

As to speed, the vessels frequenting the Suez Canal, while actually in movement, made the rate of 5·9 miles per hour in 1876, which has fallen to 5·1 miles per hour in 1882; the size of the vessels having increased in the period from 2,100 to 2,400 tons. 4·5 miles per hour is attained on the Goole Canal; 4·6 on the Ellesmere Canal; from 5 to 6 miles per hour on the River Severn; 7 miles on the Liffey; and from 8 to 9 miles an hour on the Clyde, by boats which can make from 16 to 18 miles per hour on sea. The variations of speed closely coincide with those of the depth of the channel, and with the relative cross sections of boat and channel in each case. The ordinary running rate of mineral trains on railways is 15 miles per hour, so that the comparison which is ordinarily made of weeks of water carriage against days of railway carriage is by no means unjust to the latter. It is not very far from the outcome of these figures to say that a fourfold speed is attainable at the expense of a fourfold cost. As to this, it is the contention of the writer, that the freighters should be allowed freedom of choice. Rightly considered, the interests of the carrier on the one hand, and of the freighter on the other, are constituent elements of the nation's welfare. It is a loss —it may prove a fatal loss—to the nation to deny to our inland towns facilities for the cheaper mode of transport, that is to say, for water transport. It is a loss to the owners of railways to carry heavy goods at less than three times the cost of carriage by canal. The impoverishment and ruin of the manufacturer would be a national disaster. It is mere loss of time to inquire which of these evils is the greatest. The part of wisdom is to avoid them all. This is now possible. It may by-and-bye be too late. To neglect the true solution of this vital question is little short of national suicide.

TRANSPORT BY CANALS AND RAILWAYS.

By G. Lester.

History of Canals.

The path, the road, the railway, the river, the canal, the sea. These are the means by which internal, international, social, and commercial development and progress is possible. Any restriction in the free use of either of these is highly prejudicial to the interests of the community at large.

Most of our canals were cut in the middle and latter end of the last century, when, though trade was very limited, even then a cheaper mode of transit than by pack-horse or waggon became a necessity; for, with costly carriage of passengers and goods, prosperity was more the exception than the rule.

The canals cut prior to the year 1848 were projected and carried out by a combination of landed proprietors. The River Weaver Navigation and the Trent and Mersey Canal are two instances, the former being handed over to a county trust, with the result that Northwich, although 35 miles from Liverpool, can barge its salt for sixpence per ton, and consequently, commands the trade of the world, with the additional fact that one has increased twenty times in value, and the other nine times, and, if the latter had not been in railway hands, would have increased in the same ratio.

The railway monopoly of canals dates from 1847 to the present time, and is treating them in a most hostile, arbitrary, unfair, and illegal manner. Seeing that there was no possibility of railways contending against canals, and, as is always the case where enormous profits can be made by the landed proprietor, legal practitioner, speculator, and contractor, each one in and out of Parliament used their power, and obtained possession of the principal navigations, and so broke up the continuity of the canal system; reducing railway rates to starvation point where water competed, and putting on most onerous charges where the monopoly was complete, so complete that agriculture and commerce are suffering most grievously, and that as a nation instead of the cheapest we have the most costly transport in the world.

The post railway era dates from 1887, when the greatest work ever attempted in this country was began, viz., the Manchester Ship Canal, and it is hard to say which is the most to blame—the costliness of Parliamentary, legal, or landed interests — all being the greatest enemies to the progress of arts and manufactures. Manchester has fought wisely and won well; it is now for the ports of London and Liverpool to join in promoting a good inland canal. Hull and the Severn should also be joined in the same way; there need be no jealousy. Our inland industries

have enormously growing lungs, which only want free play for agricultural and commercial expansion through good canals to our ports. More will be exported, more will be imported, but this can never be till improved, and free from rail control, navigations intersect the country; and when such is the case, and only then can we, as a nation, fearlessly compete successfully with the nations of the earth.

Canal Engineering.

Engineering can hardly apply to our canals, most of them being mere ditches. £1,500 per mile was the total cost of one of our most important canals. All our waterways are too much alike, too small in locks, gauge, and depth, the motive power being the most primitive, crude, and wasteful. Imagine the power required to haul a 10-ton truck of coal to London, with horse and truck moving in eschelon, and this is actually how most canal haulage is carried on. In cutting an inland navigation it should be considered when well done it is a work for ever; the lowest levels should be taken so as to utilise all available water. Canal engineering is only in its infancy. Let the scientific man give a depth of water, then the commercial man will soon put barges on that will carry for a minimum. Hitherto the shallowness of canals has been the great drawback, but a greater still is the want of walling on both sides; owing to the want of these steam cannot be applied. The application of hydraulic lifts makes canals adaptable where hitherto they were not practicable. While waste of water is reduced to a minimum, they are much more expeditious, and almost solve the question of difficulty of water supply.

Foreign Canals

Offer a great contrast to our own, they having deep and well-planned waterways for a comparatively small traffic, whereas we have small canals and large traffic. Foreign navigations are treated like our highways, are cut, improved, and controlled by the various Governments for the development of trade and commerce. The Suez, Panama, Nicaraguan, and other canals point us to the necessity of seeing to our inland means of transport. America, feeling the absolute control railways have over trade, has sent a number of questions to her consuls abroad as to the respective cost of canal transport in all countries, and thus a consensus of information and opinion has been obtained which proves most conclusively that water carriage is the cheapest, best, and almost the quickest media of transit, as our ocean and even our inland steamers testify.

Present Condition of our Canals.

Deplorable in the extreme, nearly all the energy, enterprise, and money having been expended on railways, while in many cases rails and sleepers are put where once the canal used to be, and where this is not so navigations are allowed to silt up, preparatory to which everything is done by the railway director, manager, speculator, &c., to ruin a canal, and bring into contempt that media which reduces to a minimum the non-producing element of which railways are so redundant. The resuscitation, improvement, and ultimate restoration of canals is not to be left to the manufacturer or merchant—each has enough, and often more than enough, to do to conduct successfully a business intricate in the scientific as well as the commercial part. Both foreign agriculture and manufacturing interests are provided with almost toll free navigations by their respective Governments. Shall it be left either to private speculators or railway rings to buy up our canals, and lay the embargo of an unearned increment on our future trade, as was done by Sir E. Watkin and several other railway directors in their private capacity. £800,000 was given for the Bridgewater Navigation to Manchester, which was sold to the Ship Canal Company for £1,710,000. In the case of the Birmingham Canal, £55,000 being the value, the London and North-Western Railway Company gave £2,380,000,* and guaranteed 4 per cent. in perpetuity, a proviso being inserted that if the navigation did not pay this

* [The accuracy of this statement having been questioned in the discussion, application has been made to the Birmingham Canal Company for an authoritative statement as to their original capital and the arrangement with the London and North-Western Railway Company, and the editor has been favoured with the following official reply:—"The arrangement between the Birmingham Canal Company and the London and North-Western Railway Company, is set forth in the Arrangement Act of 1846. Under this Act the railway company undertook to make good any deficiency up to £4 per share per annum, on 17,600 shares in the canal company, being the number of shares then existing. Of these shares 16,000 represented 500 consolidated shares, into which the united capital of the original Birmingham Canal Company and the Birmingham and Fazeley Canal Company, amounting together to £185,000 had been divided, and on which a further sum of £55 10s. per share had been also paid, making together a payment, in respect of each of those 16,000 shares, of £47 1s. 3d. The £185,000 was made up of Birmingham Company £70,000, Birmingham Fazeley Company £115,000: £185,000. Except any monies that have been paid under this guarantee, the railway company have never given the canal company £2,380,000, or any other money."]

160 per cent. on its original capital, the majority of the directorate should be railway men. Leeds and Liverpool, Thames and Severn, Norwich, Trent and Mersey, and many other navigations can be cited as being tampered with, and their ownership by railway companies being most grossly abused to the detriment of commerce generally. The first step to permanently improve canals is the taking of them out of the hands of railway companies, and forming them into public trusts, after the manner of the River Weaver, which is managed by a board of county gentlemen, part of the receipts going to keep in repair, improve the navigation, and the remainder, a very large surplus, goes to reduce the county rates.

In October last, at Exeter, and again, in February last, at the Associated Chambers of Commerce meetings, I moved, and it was carried :—"That the railway monopoly of canals is ruining the trade of the country, and that powers be given corporate and other public bodies, to acquire, improve, and contribute to promotion of canals."

Last month, I moved the insertion in the Railway and Canal Traffic Bill—Clause 36, Section 3 :—"Where a railway company, or director, or officer of a railway company, or other person, have previously to this Act become possessed, by Act of Parliament or otherwise, of any canal or navigable river, where such possession is detrimental to the trading interests of a district or districts, such canal or navigable river shall be valued; the railway company to be paid, or if of less value than when acquired, such sum to be refunded by the said railway company (unless through no fault of the said company), the navigation to be formed into a public trust, under the direction of the Board of Trade;" and Clause 39, Section 1 :—"That powers be given to county, local, and corporate bodies, either separately or collectively, to form public trusts for the acquiring or promotion of canals, and to contribute to or subscribe funds for the promotion of such canals."

I should deem it a great encouragement to arts, manufactures, and commerce if this Society would support and pass the foregoing resolutions.

Mutual Influence of Canals and Railways.

Two very important factors in our mercantile machine are our canals and railways, united in end and aim they prosper, contending and contentious they all suffer; what one can do the other cannot; the seeming placid weakness of the one is stronger than the undoubted strength of the other; one is the racehorse, the other the elephant, and for the last forty years the fleetest has been trying to do all the work in hopes that it alone would remain to tell the tale of prosperity. Like the spendthrift, railways have commanded all the confidence, all the capital of the country, and like the manufacturer who trusts to general results, despising estimating cost and economic laws, with the result—£800,000,000, and only 20,000 miles of railway as an asset, whereas for the same money America has 130,000 miles of railway. Sir Andrew Cotton estimates that canals not being improved have lost, and are losing, £40,000,000 annually; this is the difference between cost of canal and railway traffic. As to canals and railways working for each other's mutual good, it is impossible, one is so diametrically opposed to the other; a canal can carry ten times the quantity at one-tenth what a railway can. If the railways had taken the passenger and light traffic, canals taking the heavy work, the saving in cost of transit would have enriched master and man equally, by finding more trade for the one, and increased work for the other; this would mean increased railway travelling.

The importance of means of transit is very imperfectly understood, although its necessity is forced upon the people of this country by the keen competition of and the ever increasing imports of foreign agricultural and mercantile products to meet this; whether it be the miner, mechanic, worker, or farmer all must be put on the same footing, and have the same facilities of transit as the foreigners.

Cost of Transit by Canal and Railway.

The costliness of railway carriage is enormously enhanced entirely through the action of Parliament, whose first duty is to legislate for the good of the majority, acting at the same time fairly to the minority. In the case of all public works—such as railways and canals—the appetite of the property owner is insatiable, and however value may ultimately increase through the railway being cut, this is not looked upon, but get all you can is the motto; frequently for land worth £100 an acre £800 is demanded, or a landed proprietor will not sell at any price. Land is not like any other commodity; on its being opened out depends the future prosperity of locality or country. By a prominent member of Parlia-

ment it was lately admitted that £200,000,000 too much had been paid forland and law by our railway companies. Another M.P. stated, that if a railway could be made to America it could no more compete with our steamships than fly. There is no doubt that the first cost of railways must be reduced from £40,000 per mile to £20,000, and even then the cost of management, wear and tear of permanent way and rolling stock, is enormous. It is estimated the cost by road is 1s. per mile, by railway 2d. per mile, and by canal 1-12th of 1d. per ton per mile. One railway manager has stated coal can be carried for ¼d. per ton per mile. Why is over ½d. per ton charged—what should be the dividend if this ¼d. was the profit? For 150 miles by canal a charge of 4s. is charged for toll alone, besides which barge men and power have to be found. The North Staffordshire Railway Company, who own the Trent and Mersey Canal, lose money by carrying on their canal. The London and North-Western Railway Company do so as well. Does not this show the real fault is that either a railway or canal should be free to all senders to find and use their own vehicle, men, and power? It will be urged that on railways this could not be done. Then they are unsuited for the conveyance of merchandise, and are bound to be the dearest medium. Foreign dead meat, Liverpool to London, a few weeks ago was carried for 25s., home meat 50s. The latter is very rightly reduced, but only because of agitation, to 25s. per ton. Foreign produce, whether raw or manufactured, has always preference rates over our own material. It is urged because of the quantity being larger, but seeing any number of trucks can be added to a train, this argument falls to the ground. We are now threatened by railway companies that our import and export rates will be raised. "This will be worse for the consumer." With canals improved and out of the hands of railway companies, we should have much cheaper inland carriage—which means cheapening the material produced—and also much lower rates than our import and export rates now are. To most inland centres London aad Liverpool are the two large markets. Take pottery; if from Germany, France, Belgium, Sweden, &c., 7s. per ton is the freight, whereas for 150 miles by rail to London the rate is 30s. per ton. Maastricht can send ware to Burmah for 10s. per crate less than we can; this in carriage alone means £100 per week to a large firm. Pottery can be sent to London *viâ* Liverpool and New York, nearly 7,000 miles, for less than direct to London by rail; and if London sends tea, coffee, &c., to the Midlands, it costs less *viâ* sea 700 miles and than to deliver by canal barge 50 miles inland.

Earthenware and china are light goods compared with iron, coal, &c. In evidence over the Wrexham Connah's Quay and Liverpool Railway Extension Bill, Mr. Gladstone said 3d. per ton was a question of opening and closing works. With our Midlands it is shillings per ton. One colliery had its rail rate to London raised £15,000 per year, and whenever an inquiry for a rate is made, the question put is—What will the traffic bear? There are so many incidental expenses in conveyance by railway, it is impossible to give or define any exact cost, but by canal the exact amount can be given, there being only interest on capital and repairs to permanent way, the bargemen and power being found by the carrier. If the distance be 40 miles, the cost of haulage, boatmen, and horse, is ½d. per ton per mile; for a distance of 200 miles, the proportionate cost would be one-third less. Given the haulage, &c., is 5s. per ton for the whole distance, increase the capacity of the barge from 20 to 120 tons, apply steam, you gain in speed, economise time and labour, therefore the 120 tons can be taken for the same as 20 tons; the cost of haulage is reduced from 5s. to 10d., or, say, 1s. per ton. In support of the cheapness of steam over animal power—take a tug partially laden, hauling 500 tons in barges. The cost of the steam-power is minimised to such an extent, that 1¾d. per ton will suffice to pay the expense of traction the whole distance. These, and like figures, have been questioned before a Parliamentary Committee, are questioned by railway men, and are not believed by the public, but, being the result of actual experience, they cannot be gainsaid or refuted.

A question is often put—What of railway vested interests? Are they to be sacrificed? 500,000 shareholders have invested their money on the faith of Government granting a monopoly. Such exclusive right was given, but when it can be proved the trust is abused, or such monopoly is detrimental to trade—like any other joint-stock company, they must submit to competition. Are the interests of 34,000,000 of people to be sacrificed to a body that has boycotted trade for so long?

Mr. Gladstone, in a debate on the Railway and Canal Traffic Bill, said, "never was a more important Bill introduced." No monopoly

has ever injured art so widely or so much as the question of monopoly of transport; it has affected the rich and well-to-do most seriously, and has even lowered the standard of less artistic goods. All classes of goods have been injured, but more especially those of merit and value.

To attack the railways, to put them right, or to ruin them, no true canal advocate would recommend. All asked for by barge owner, bargee, and artisan is that a moderate navigation be provided—a fair field and no favour; no railway-owned canals, but let all be owned by public trusts—county boards or corporate bodies—in the same way that the county of Cheshire has a trust to manage the navigation to Liverpool. Then thousands of tons of sewage would be distributed over the land at a minimum cost, the very cheapness of transit would create traffic, a turn in trade would soon ensue, confidence would be restored, land would regain its lost value, and manufacturer and artisan would once more have no lack.

CANALS AND INLAND NAVIGATIONS PROPERLY NATIONAL WORKS.

By General Rundall, R.E., C.S.I.

That the subject of water-carriage should be deemed of sufficient importance to lead to the assembly of a Conference by so influential and representative an institution as the Society of Arts, is a very hopeful sign that the nation is awakening to the mistake under which it has hitherto been labouring in supposing that its nearly perfect system of railways has met the requirements of trade, and that the limits of cheap transport have been reached. Why, when all the other chief nations in Europe have for some time been endeavouring to solve the question as to the best mode of not only improving their existing water routes, but also of extending them, even to the length of inaugurating an International system, the English nation—which always has been, and is still, the foremost in perfecting the system of ocean transport—should be the last to recognise the error of neglecting its inland waterways, is one of those extraordinary instances of infatuation which it seems impossible to explain. Now, however, that that stage in our history has been reached when the question is not merely whether our ancient commercial supremacy is seriously threatened, but rather whether its very existence is not imperilled; it becomes an absolute necessity to guard against our being left behind in the race. It behoves us, then, to take care that we do not miss the lesson that is being taught us by those continental nations, who are fast wresting from our manufacturing and commercial classes not only the position, wealth, and importance inherited from our forefathers, but absolutely, in many industries, their very means of existence.

The fact that with the exception of coal and iron we are obliged to import all the raw material required in our various manufactures, at once indicates one important if not the chief factor, which if it does not absolutely dominate and regulate the cost of such manufactures, at all events forms a very large share in determining the cost of their out-turn; but, happily, it is one over which we can, if we will, exercise a very efficient control. To regulate the other factor, the price of labour, is in these days a more difficult problem, and as we seem to have arrived almost at the limit of supplementing manual labour by automatic machinery, there is little to look to for further reduction in this direction. So long, then, as our Continental neighbours shut their eyes to the benefits of reciprocity in fiscal arrangements, the only opening in which there seems to be a possibility of at all events diminishing the odds against ourselves, is in an endeavour to reduce the cost of transport both of the raw material and of the finished product.

How is this to be managed? No one will deny that there are certain classes of goods which cannot be carried by land at lower than the existing railway rates, and it is well known that those rates in several instances barely if at all cover the working expenses. Now, this is a problem, the right solution of which, affects not only the interests of carriers or even of producers and consumers, but it is not too much to say imperial interests are also seriously concerned therein, especially in the case of an essentially commercial nation like ourselves. It is a mere truism to aver that our national wealth must advance or decline just in proportion to the prosperity or otherwise of our commerce, and if, as is the case at present, we are being beaten out of the field by the cheaper production of our neighbours, a permanent decline in our prosperity must inevitably ensue. It is time, then, to lay aside our prejudices and examine into a question which vitally affects our *national* interests. I use the word "national" advisedly, for I am

sure that on its right appreciation the solution of this question depends. So long as we are content to leave our inland communications to be dealt with by local or party interests, it is perfectly certain the question will never be satisfactorily solved. It is of little use continuing to affirm that it is the instinct or the practice of the English nation to leave all such matters to private enterprise, and to point, as is usually done, to the magnificent lines of communication which cover our country as the outcome of such enterprise only; for are we not at this very moment suffering from the effects of having left those very communications to be so carried out independently of State control; and are not the trading as well as the general community crying out against the combination of which such absence of control has been the cause?

What are the Railway and Canal Bills now before Parliament but a confession of failure in this respect? Why are remedial measures so urgently demanded by the trading community? How comes it that preferential rates are accorded to the products of foreign countries to the detriment of our own? Why is it that, already handicapped by unavoidably higher rates of wage, British manufacturers and producers have to submit to the additional burden of higher rates of carriage within the limits of their own country? The very difficulty encountered in legislating for remedial measures is evidence of the fatal mistake that was made at the outset by the Parliament not reserving an adequate and effective control over what was essentially a national question. If, then, the Legislature is about to take up the subject earnestly, and is desirous of remedying that mistake, would it not be wiser to deal with this question of our communications as a whole, rather than to devise remedies which can be but partial, and which still leave untouched the principal point of providing for the general benefit of the whole country such modes of transit as are best suited to its various requirements.

Perhaps I may here be allowed to quote an extract from the memorandum which I had the honour to lay before the Select Committee on Canals in 1883.

"What is needed is not a ruinous competition amongst carrying companies in order to provide accommodation for the trade of the country, but an intelligent distribution of the traffic amongst the different modes of conveyance best suited to it. The re-establishment of water carriage on an effective basis in England need not, and would not, interfere (except beneficially) with the financial results of railways, for it would not only relieve them from the bulk of their least remunerative class of traffic, but set them free to provide larger and more convenient accommodation for passenger traffic, as well as for the extensive class of light and valuable manufactured goods. It would also greatly tend to diminish the number of accidents as well as liabilities to heavy compensation arising therefrom, would lessen the wear and tear of both 'way' and rolling stock, would enable the railways to contract their overgrown establishments, and so by reducing the per-centage of working expenses, tend to increase rather than diminish the dividends."

In a paper read before this Society in 1884, I entered at length into the advantages afforded by water transport, and enumerated likewise the defects existing in the system of canals in England; but as perhaps that paper has not been seen by many attending the present Conference, I may be excused for repeating what I then wrote.

The advantages afforded by canals may thus be stated:

1. They admit of any class of goods being carried in the manner and at the speed which proves to be most economical and suitable for it, without the slightest interference with any other class.

2. The landing or shipment of cargo is not necessarily confined to certain fixed stations, as is obligatory on railways, but boats can stop at any point on their journey to load and unload, and discharge their cargoes direct over the ship's side.

3. The dead weight to be moved in proportion to the load is much less.

4. The capacity for traffic is practically unlimited, provided the locks are properly designed.

5. There is no obligation to maintain enormous or expensive plant or establishments, as all those can, and would be, provided by separate agencies and distinct capital. Thus a large outlay in first cost and subsequent maintenance of rolling stock is avoided.

6. An almost total absence of risk, and the reduction of damage to cargo in transit, and consequently of insurance, to a minimum.

On the other hand, the defects, besides those of original construction in existing British canals, are:—

1. A total absence of unity of management. For example, on one of the routes from London

to Liverpool there are nine different canals and navigations; on another also there are nine, and on a third ten different companies.

2. A want of uniformity of gauge in the locks, as well as in the canals themselves.

3. With few exceptions they are not capable of being worked by steam.

4. An unequal system of tolls.

5. Last, but not least, the fact of so many links in the communications being in the hands of the railways, paralyses any unity of action, and renders any scheme of amalgamation between the several lines impossible.

If a restoration or extension of its ancient water lines is to be undertaken in Great Britain, it is essential that it should be devised on the most improved principles. The chief points requiring attention may be summarised as follows:—

1. The dimensions to be given to the main lines, with the best relative proportion of width to depth.

2. Uniformity of gauge in the locks or lifts, which should be so designed as to ensure changes of level being overcome in the quickest manner possible, and of a size suited to the maintenance of the most effective steam traffic.

3. The remodelment of the cargo boats so as to obtain the largest carrying capacity with the least amount of sectional and frictional resistance.

4. Provision for working the canals day and night with the help of the electric light, the power for maintaining which would be easily and economically obtained at the various changes of level.

5. The construction of landing stages, with suitable modern appliances, for facilitating the shipment and discharge of cargo.

6. A readjustment of, and uniformity in, the rates of toll.

7. A careful revision of the administration, and the establishment of special effective supervision over the whole system.

But how are all these improvements to be inaugurated, and by what agency are they to be effected? It is the very essence of the principle which I advocate that before anything is undertaken there should be the creation of a central authority, such as a Water Commission, on some such basis as that of the existing Railway and Canal Commission, only so constituted as to ensure an adequate representation of the various interests concerned in their engineering, commercial, legal, agricultural, and financial aspects. To it should be confided all subsidiary arrangements as to local supervision, the composition and responsibilities of conservancy bodies, and the limits of their respective authorities, in fact the settlement of all administrative details; the Commission itself to be responsible to the nation through Parliament, to whom it should annually render an account of its stewardship.

The suggestions I have made relative to the State acquiring the canals are not new, but have been acted upon already in the case of other public works. It has not hesitated to acquire possession of all telegraphic lines. It has reserved to itself the right of purchasing railways, a right which it has exercised already in India. It has insisted on inserting a clause in the case of Electric Light Companies empowering it to buy out the company after a given term of years. Bills have been laid before Parliament with a view to buying up the Metropolitan Water Companies. Why then should the line be drawn at these, and it be thought inexpedient to acquire canals, which would be not only a much less expensive operation, but one of far greater importance, inasmuch as in the one case it would be merely the interests of the metropolitan area, and in the other those of the entire United Kingdom that would be affected?

An idea of the extent of the financial operations that would be entailed by purchasing the canals, and the interests involved may be gathered from the following remarks, in the paper from which I have already quoted.

"The capital cost of the 4,000 miles of British Canals has been variously estimated at a mileage rate of £3,500 to £5,000, to stand at from £14,000,000 to £20,000,000, while the improvements to the main lines, in order to fit them for steam traffic, has been calculated at from £5,000 to £12,000 per mile. If two of the principal lines were first taken in hand, one running north to Liverpool, and the other west to Bristol, from London, the metropolis and ports would then be connected with the districts yielding the three great products of coal, salt, and iron, and with the three great manufacturing industries in cotton, pottery, and hardware. Along these two lines there would also be moved much of, not only agricultural produce, but farming requirements in general. It cannot be doubted that if the charge for carriage were reduced to one-tenth of a penny per ton-mile, that is, two or three shillings a ton between London and Liverpool, the traffic would be enormous, and every class of the

community, both producer and consumer, would be greatly benefited. Take for instance the single item of coal, a reduction of even 30 per cent. in which would be an inestimable boon to every householder in the metropolis, if not throughout the United Kingdom. Then as regards the financial arrangements—at the present value of Government securities there would be no difficulty in raising a Government Water Loan, at a low rate of interest, just as has been done in the case of the Telegraph, and as would assuredly be done again were the scheme of buying up the metropolitan water companies ever carried out."

But whatever may be considered the proper limit of control to be exercised by the State whether as proprietor of the canal, or merely the protector of the public interests, or in the management only of the financial arrangements, I would again repeat my own conviction, based on the experience of a life-time, that the question of the communications of a country is of essentially *national* importance, and as bitter experience is at the present day proving, it cannot and must not be entrusted to or dealt with by any private or local association whatever, but that the interests of the community must be safe-guarded by being kept more under the immediate and direct control of the State itself.

Assuming, however, for argument's sake, that there may be technical objections difficult to be overcome to the Government purchasing the absolute rights of ownership of the existing canals, yet in the light of the complications which the absence of an efficient control over the system of railways has engendered, it cannot be gainsaid that, if the water-carriage of Great Britain is to be put on an effective footing, and the interests of the proprietors as well as those of the public are to be simultaneously protected, it will be absolutely necessary that some kind of institution, such as a Water Trust, should be created, under whose single administration all water questions should be brought.

In the Report of the Select Committee on the Public Health Act Amendment Bill of 1875, amongst other recommendations were the following important remarks:—"It is essential to an economical as well as efficient sanitary improvement that the works should be carried on under one management. . . . That the abandonment of the water supply to private companies involves disregard of the public interests on important points. . . . That by the execution of these works as public works . . . all risks are saved to the capitalist and the consumer. . . . That their execution will be best effected by unity of design and direction in the hands of a very few competent paid officers, giving their whole time and attention to the objects to be attained until they are accomplished. . . . That the proper execution of the works will be best guaranteed, the responsibility of the persons charged with their execution best ensured, and the interests of the poorer classes of the population best guaranteed, by the control of Parliament."

Every word of those recommendations applies with equal force to the restoration of a system of water transit. The recent Royal Commission on Irish Public Works proposed that there should be a representative body for each river basin of importance. Why should there not be a similar body for the river basins of Great Britain? The sooner this question is taken up the better. An excellent article in the *Standard* of the 15th March last, on "The Anticipated Drought," shows the serious state to which the country has been brought for want of a proper regulation of its waters. The writer says, "It is no longer possible to depend upon the year's rainfall for the supply of the great centres of population. Every catchment basin must be prepared to supply its own population, and this question becomes year by year more pressing. . . . We must, therefore, be prepared to store the superfluous rain of a wet year for the needs of a dry one."

The whole article, singularly, advocates the very views which I put forward in my paper from which I have already quoted, and though apparently written with reference to providing simply a supply of water for towns and agricultural necessities, it tells of course all the more forcibly when an additional volume for navigation purposes has to be procured.

In France 16 years ago a very able inquiry was instituted under M. Krantz into its water resources and management, and resulted in the adoption of many very important measures. A similar inquiry is very much needed for Great Britain, and might embrace a general report on the utilisation of its rivers, and a local special report for each basin. The larger question of giving sea-going vessels access to the great manufacturing centres, such as Manchester and Birmingham, has already passed the stage of investigation, and will ere long be an accomplished fact. The connection of such chief centres with each other, and with the metropolis, as well as with the minor manufac-

turing towns, by canals capable of conveying boats of from 300 to 500 tons burthen, as in the Belgium and French canals, must follow as a matter of course, but instead of leaving such schemes to be initiated and worked out by independent bodies, how much better would it be to inaugurate a thoroughly comprehensive system by some recognised and capable a Commission? Surely the present Government, which has already shown itself to be in sympathy with the opinions of the day, and its desire to meet the demands of the nation by the introduction of such a measure as the Local Government Bill, will not be slow to respond to appeals made by influential representative bodies like the Canal Traders' Association. Could not the Society of Arts then, which has done so much in the way of advancing the more particular objects which originated its existence, and which is supported by the most exalted personages, as well as the most representative individuals in the realm, exercise its functions most legitimately towards advancing the interests of the kingdom by aiding the Trading Associations in petitioning Parliament for the appointment of a Royal Commission for the purpose of carefully investigating and considering the all-important subject which has called this Conference together.

Colonel CAMPBELL said General Rundall, who was not able to be present that afternoon, had been in communication with him, and his great dread was that the Conference might discuss a great many points, and finally break up without taking any definite action. The last paragraph of his paper contained the suggestion that a movement should be made to obtain a Royal Commission to inquire into this matter, and to take up the inquiry which came to an untimely end some years ago, when a House of Commons Committee was appointed. He would therefore venture to suggest the following resolution:—"That in the opinion of this Conference, the Society of Arts will render national service by endeavouring to secure the appointment of a Royal Commission to consider the utilisation of the river basins of the United Kingdom, and their waterlinks." It was desirable to consider the matter as much as possible as an economical question. A great deal had been said about canal-engineering and other matters, but it was desirable to approach the matter in a comprehensive spirit. It was really impossible to treat this question properly from one point alone. It had been shown by General Rundall, in a paper read to the Society of Arts some years ago, that it was impossible to separate the question of transit from that of drainage, water power, fisheries, sewerage, gathering-grounds, and other matters. There was rather a disposition to separate things; for instance, to keep navigation apart from drainage, and in the case of Birmingham it seemed as if the Committee desired to further separate transport into two parts, the imports to go one way, and the exports another. Everyone knew that it was only by concentrating a large quantity of traffic in one line that economy could be effected. A good deal had been heard about the rates at which goods could be carried by water, but the estimates varied a great deal, and something like a normal rate of transport should be ascertained. In France, both the localities concerned and the central Government were united in the management of the canals; the localities for the benefit of the rates; the Government for that of the taxes. In Scotland and Ireland, the State not only advanced money, but retained in its possession many of the waterways of the kingdom. What was wanted was to raise the whole question out of the realm of private interests, and he thought that nothing could be better towards the accomplishment of this end than the appointment of a Royal Commission, which would take the evidence of experts and partisans on all sides, and finally bring a judicial mind to bear on the whole question.

Sir EDMUND LECHMERE said he did not desire to interrupt the course of discussion of the papers at any length, but he had great pleasure in seconding the resolution. As a member of the Select Committee on Canals, which sat in 1883, and also being connected with the large navigation of the River Severn, he took a great interest in the matter. It was most important just now, when the House of Commons was going into committee on the Railway and Canal Bill, that the question of canals should not be altogether passed over. In the discussion in the House last night, statements were made about canals by Sir Bernhard Samuelson which ought not to have passed uncontradicted, for what he had said was not at all borne out by the facts laid before the Committee in 1883.

Mr. H. J. MARTEN said the resolution did not say anything about the arrangements to be adopted with regard to canals, which was the object of the Conference. The river basin was a different question altogether.

Colonel CAMPBELL said in France the country was divided into various sections, including the most important river basins, on each of which a separate report was made, and finally a general report was drawn up on the whole.

Mr. MARTEN said there had been a report on the river basins of England already, and the object of the Conference was to deal with the canals.

Mr. CHANCE (Gloucester) said he had drafted a resolution which he would not have brought forward in opposition to the one already proposed, except for what seemed to him to be the fatal objection to that one, viz., that by relegating the matter to a Royal Commission the question would be hung up for several years, whereas it seemed to him that the tone of the meeting yesterday, and of all the papers and discussions, pointed to the necessity of something like urgent and immediate action. He had no special knowledge on this subject which would entitle him to dogmatise in the presence of such an influential gathering including many eminent experts; but as an endeavour to give practical effect to the proceedings of the Conference, he had formulated a resolution which he would venture to read: "That the Legislature should seriously consider the necessity of encouraging and assisting the improvement and extension of the canal system, by State acquisition or otherwise; and that meanwhile the Conference urges the Council of the Society of Arts to petition the House of Commons for the amendment of the Railway and Canal Traffic Bill by authorising local authorities to constitute Public Trusts for the development of the existing system of canals." The debate which took place last night in the House of Commons was somewhat disappointing, and he hoped the President of the Board of Trade would take a larger view of the matter. As to the question of State acquisition of canals, that would no doubt require a great deal of consideration, but if anything was proved it was that their present condition was a serious hindrance to the national prosperity, and that the proper construction and improvement of canals was, in many districts, beyond the capacities of private enterprise. It naturally followed therefore that the State should seriously consider how it could promote the extension and improvement of canals, and the motion of which notice had been given by the Hon. Philip Stanhope seemed to provide a method of getting something done. It was in evidence that where public trusts existed they were beneficial to the commercial interests of the district, and in many cases, as in that of the Weaver, the income was sufficient to leave a considerable surplus for the reduction of local rates. That was a strong argument for entrusting the ratepayers with powers, not to squander their resources, but to confine themselves to judicious expenditure, such as would develop local traffic, and diminish local rates. Sir Michael Hicks-Beach very wisely deprecated entrusting local authorities with unlimited powers, but they might fairly ask that the Government should undertake to consider schemes prepared locally for that purpose, and the Board of Trade might embody what they considered to be judicious in provisional orders, which should then be brought forward for Parliamentary sanction. It seemed to him that powers so judiciously restricted might be safely entrusted to local authorities. As an example of the necessity for such action, he might say that in Gloucester they were very anxious to get an extension of their canal system, but at present they were in this position: they could demonstrate absolutely that the work required to be done to regenerate the commerce of the district, and avert impending ruin, would be remunerative if undertaken by a Public Trust; but they were obliged to admit that their own local resources were not sufficient. It was a matter of life and death to them, and no doubt their district was typical of many parts of the country, in which canal improvement was the only means of extending commercial prosperity.

Mr. WILLIAM EVANS (Kenilworth) said he would take the liberty of suggesting an amendment to the resolution proposed by Colonel Campbell, to this effect: "That in the opinion of this Conference the Society of Arts will render national service by endeavouring to secure the appointment of a Royal Commission, or a Select Committee, to consider the subject of inland water navigation." Whether the larger subject should be dealt with or not was a matter perhaps for prolonged consideration, but it was hardly one for such an assembly as that, which had met for the purpose of considering the subject of canals. The questions with regard to rivers and drainage, and cognate questions, were scarcely pertinent to the Conference. No one could desire that canals should remain in their present position, but to plunge into a resolution such as that suggested by the last speaker was more he thought than they were prepared for at present. To hand over all the canals to some public trust was rather a leap in the dark. He for one did not know to whom they were proposing to hand these canals. What was meant by a public trust? They were told in one breath that the effect would be to so reduce tolls that the traffic would increase enormously and the public would be greatly benefited; that the railways were not to be attacked, though of course they would lose some of their traffic. Of course that meant that there would be a very low toll, but then, on the other hand, they were told that not only would there be this advantage to commerce but the local rates would be benefited through the profits on the canal. These two things did not seem to run on all fours. It might be that the reduction of toll might increase the traffic to some extent, but there might be a point below which the reduction, though benefiting the customer, would not be a benefit to the ratepayer. All these were difficult questions, which would require more than three days to argue out. With regard to Mr. Lester's paper, he had ventured to interrupt him while reading it, to state that if all his figures were not more accurate than those which he used with regard to the Birmingham Canal Company, for which he (Mr. Evans) was for many years the solicitor, and of which he was now one of the committee of management, in conjunction with the Chairman, Sir Douglas Galton, his figures were wholly misleading and inaccurate. Mr. Lester had stated, as an illustration of the great pro-

gress made by canals, that "in the case of the Birmingham Canal Company, £55,000 being the value, the London and North-Western Railway Company gave £2,380,000, and guaranteed 4 per cent. in perpetuity, a proviso being inserted that if the navigation did not pay this 160 per cent. on its original capital, the majority of the directorate should be railway men." The gentleman who wrote that must have been in dreamland; first of all, the London and North-Western Railway Company had not acquired it. They were not owners of the Birmingham Canal, neither did they give the canal company £2,380,000, or any other purchase money for it. For some years previously, and up to 1844, the Birmingham Canal Company were paying £2 to £5 per annum on each of their shares. In 1846, an arrangement was entered into, which was set forth in the Act of Parliament, to the effect that, if in any year the canal company did not earn sufficient to enable them to pay £4 per share in the year, the London and North-Western Railway Company —then the London and Birmingham Company—were bound to make up the deficiency. There was not one word about acquisition, but there was this further provision, that in any year subsequent to that in which the railway company had to make up any deficiency, they should have a casting vote on the committee of management for that year only. He thought it only right to make these rectifications. Then Mr. Lester also said, "To attack the railways, to put them right, or ruin them, no true canal advocate would recommend," and he agreed most cordially with those observations. He only regretted that the writer should have penned other paragraphs in the same paper, such as that which stated "The railway monopoly of canals dates from 1847 to the present time, treating them in a most hostile, arbitrary, unfair, and illegal manner," and again, "The first step to permanently improve canals is the taking of them out of the hands of railway companies," and again, "A question is often put, what of railway vested interests, are they to be sacrificed?" "When it can be proved that the trust is abused, or such monopoly is detrimental to trade, like any other joint stock company they must submit to competition. . . . Are the interests of 34,000,000 of people to be sacrificed to a body that has boycotted trade for so long." This must be proved first. They were not met there to attack railway companies, but to further the interests of canals, and in so doing to further the interests of the community at large. It would be a sorry day when they mixed up the two questions, and he protested against the introduction into this Conference of matters which, to his mind, were not only foreign, but inimical to the true interests of canal companies and their representatives. Reverting to the resolution, or amendment, which he had suggested, he would say that it was not with the intention of hanging up the question. He would remind them of the old motto, *festina lente*, and he ventured to suggest that they would make more progress by going slowly and carefully over the ground.

Mr. LESTER said as an aspersion had been cast on his figures he would ask the gentleman who had just spoken to state what the London and North-Western Company did give, and what the canal was valued at before they made an offer for it.

The CHAIRMAN said the London and North-Western Company gave nothing, except that they guaranteed £4 per share when the traffic of the canal did not pay that amount.

In reply to observations made by a member,

Mr. EVANS said there never was any valuation. It seemed very strange, no doubt, but he could not give the value. The original Birmingham Canal was established under an Act passed in 1768, under which £55,000 was authorised to be raised, by 550 shares of £100 each. Those shares were afterwards reduced to 500, and were subsequently divided and subdivided, and his impression was that each share in the original company at the time when the railway company bought it, in 1846, would have cost the original holder about £40. In 1846, the Birmingham Canal, as authorised under the original Act, had ceased to exist, but the canals of the company then existing consisted of the original and about half-a-dozen other canals, which had been established under different Acts of Parliament, with different amounts of shares, so that the nominal amount of shares in the Birmingham Canal could not be ascertained. That was the reply given to Lord Redesdale in 1846. They knew how many shares they had, and the guarantee was £4 on each of those shares.

Mr. LESTER said he was much obliged for the explanation, but with regard to his statement about railways having acted in an illegal, arbitrary, and unjust manner, he had had 25 years' experience in fighting the railways, and he was ready to fight them to-day, to get canals out of the hands of the railway companies. He had received a communication from the North Staffordshire Railway Company, saying that both the railway and canals were in their hands, and that he could not expect to be able to play one off against the other, and get unduly low rates, as he might possibly do if the canals were in the hands of a separate company.

Mr. ALFRED HICKMAN (Wolverhampton) seconded the amendment proposed by Mr. Chance. He did not think they had come there to try the question of the Birmingham Canal Company and the London and North-Western, but, with all deference to Mr. Evans, he did not at all concur with his proposal that they should shelve this question by referring it to a Royal Commission. From the point of view of Mr. Evans, and those whom he represented, that

might be an easy way out of the difficulty, but they had all seen enough of the question of railways and canals, and of the absence of the competition which was natural between them, to wish to have the question settled. There was a Railway and Canal Traffic Bill in Parliament, but what was wanted was a wholesome competition. In the South Staffordshire district there were three great railway companies, but, so far from competing with each other, they not only combined not to give any rate without the consent of the others, but if one found it desirable to do so from any local circumstances it was not allowed, so that in fact they were more hampered than if there were a single railway. He was once told by Mr. Moon, when he waited on the company he represented with a deputation, "It is your own fault you are paying these extra rates; when we were the only company carrying from South Staffordshire to Liverpool we carried at 25 per cent. less than we do now, because now you have three companies instead of one." Mr. Chance had said that the prosperity of trade depended on the development of the canals, but he would go further, and say its very existence depended upon it. In his district all the great heavy trades were leaving and going to the ports simply on account of the cost of carriage. They had had a very large trade indeed in the pressed nail trade, producing over 500 tons of nails a week, but that had been entirely removed to the coast within the last five years. Within ten years more than 1,000 tons of nail rods were produced in South Staffordshire in a week, and now there were not 100 tons. Within the last 20 years there were 150 furnaces in blast, and now there were not 25, and all this arose from the extraordinary and excessive railway rates. The canal represented by Mr. Evans was of all means of communication the most backward and the most exacting. The charge for raw material was $1\frac{1}{2}$d. per ton per mile, whereas on the Continent the canals carried such goods at from $\frac{1}{15}$d. to $\frac{1}{20}$d. per ton per mile, so that here in England they were charged 50 or 60 times as much as on the Continent. They were about the same distance from the coast as the great ironworks at Liege, but their rates were 10s. to 15s. a ton, whilst in Belgium they were 2s. How could they compete under those circumstances. It was a question not to be shirked but to be decided, and he thought the Conference ought to express a decided opinion, which he was sure would have great weight with the Legislature.

Mr. Daniel Adamson said he desired to give the exact figures showing the advantages that the Weaver Navigation was to the county of Chester. It paid its way and paid all its debts, and after that he knew, as a Cheshire county magistrate, that it handed over to the county £15,000 per annum in the reduction of rates. He did not think it desirable for the State to do all the work for British gentlemen and traders, but rather inclined to the principle that these matters should be left to be handled freely by the traders, the capitalists, and those who wished well for their country. He had had considerable experience and had exercised considerable patience in giving evidence before the Parliamentary Commitees in order to get the Manchester Ship Canal Bill passed. In the end they proved clearly beyond any doubt (notwithstanding it was possible nowadays, which was one of the calamities of the time, to purchase skilled witnesses to give evidence in any direction), what an immense advantage the canal would be. There must be something in the shape of a fundamental principle which would tell the trader what was desirable to do, and what was not. He was brought up on the Stockton and Darlington Railway as an engineer, and had also had large experience as a trader connected with the manufacture of cotton, pig iron, and general engineering, and upon what did he found his judgment in asking Manchester to subscribe £100,000 in the first instance to get an improved waterway right into their very midst? It was on this basis. He then understood that a large Atlantic steamer could carry at $\frac{1}{10}$th the cost under the very worst conditions that a railway could carry, that many did carry at $\frac{1}{50}$th, and some at a cost of $\frac{1}{100}$th, and was it not rational and reasonable, if water carrying was so much more economical for heavy traffic, to get the cheapest method of transit adopted. It was a very difficult work to go to the public and ask for £100,000, and ultimately they had spent in getting the Bill £148,500, but they had proved that water-carriage was by far the cheapest, and there were thousands of cases of actual practical experience, as was proved before the Duke of Richmond's Committee in 1884. It was common at that time that bale goods, sent from Manchester to India, should cost 22s. 6d., but out of that for the 40 miles and to clear Liverpool the cost was 12s. 6d., leaving 10s. for the 4,000 miles of waterway, out of which the Suez Canal dues had to come. If it were possible to carry goods 4,000 miles across the water as cheap as the country was getting its work done for 40 miles on land, besides the tax of breaking-bulk, it must be clear to everyone that what was wanted was waterways of considerable dimensions. Whatever might be said to the contrary he had sufficient experience in the estimation of cost, and in carrying out works of construction, to know this much, that if a ton could be dragged with a very limited force, say one-fourteenth of what you could drag it on a railway, it must come out cheapest in the end. An Atlantic steamer would pay all her expenses, wages, fuel, and everything for 3d. per ton per day, which, taking a 2,000 ton ship at that rate, would have to earn £25 a day; she could earn that when passing over 30 miles at a $\frac{1}{10}$th of a penny per ton per mile; but it must be said there was depreciation profit, and so on. Putting down another 3d. a ton for depreciation, a very large sum for such purpose, and then, doing as the railways did, doubling that for profit, which was another 6d., she would not

want to go more than 100 miles carrying 2,000 tons cargo to earn £100 for the day, but it was quite common for 250 miles to be a very moderate day's work of 24 hours for a steamer on the ocean, therefore, water carrying with steam power was the cheapest carrying power known to mankind, and if the position of this country were to be maintained railway companies must not be allowed to ruin business men and drive the trade from the land. Railways had done immense good to the country, for which the shareholders were paid about £620,000 a week in profit, but if the canals were increased, doubled or quadrupled, or multiplied ten-fold, his conviction was that the transport of the country would be immensely assisted, and the railways also. Instead of carrying one ton of coal at 1d. per ton per mile, and having to bring back empty waggons, they would carry 14 passengers at 1s. 2d. per ton per mile, and have as much as they could do both ways. That was what railways ought to do, to carry everything fast, to give cheap postage, and carry all letters with despatch. If Gloucester could show a clear case that it was more advantageous to enlarge the canal, or to have a waterway, certainly there was enough money in the country seeking investment if they could show there would be a reasonable dividend. Whether the inquiry was to be by Royal Commission, or by having meetings, and spreading the knowledge that water-carriage was the most economical mode of conveyance, he would not say, but if they could show the public that it was a necessity, and that they could pay a fair return, the money would be obtained, and a Royal Commission would not be wanted. Nevertheless, if a Royal Commission would bring matters to a focus, perhaps it would be the best. He was not prepared to say it would or would not, but he had great faith in leaving everything to the British trader to look after his own interests, and do it in the best way he could for the benefit of himself and the general public.

Mr. Elliott suggested that the original resolution should be withdrawn, and the amendment accepted as a substantive resolution.

Colonel Campbell said he did not wish to modify his original proposal at all. If they tried to separate drainage and transport they would find it would lead to failure and confusion.

Sir Edmund Lechmere, Bart., M.P., said he was more favourable to the resolution as modified by Mr. Evans than to the original one moved by Colonel Campbell, and he accordingly asked the latter gentleman to release him from seconding. He had to leave for the House of Commons immediately, but he was exceedingly anxious that something should be done, and was quite willing to support any resolution which met the views of the meeting.

Mr. Elliott (Birmingham) said unless they availed themselves of the opportunity now afforded in Parliament, on the discussion of the Railway and Canal Traffic Bill, they would fail to obtain any insertion in the Bill of a clause with regard to the trusts, which was the main object of every one interested in the matter. It would then be not only possible but quite easy, if it were found desirable afterwards, to memorialise Parliament for the appointment of a Royal Commission, but it would be most inexpedient to lose the present opportunity of obtaining the insertion of such a clause in the Bill now before Parliament. On that ground he urged that the resolution should be withdrawn, and that they should all unite in supporting the amendment.

Mr. J. S. Watson said referring the matter to a Royal Commission would delay it for four or five years, and it was necessary some further influence should be brought to bear on the Government. Many prominent members had expressed strong opinions in favour of the State purchase of canals. It was said they were not ripe for that yet, but five years ago it was advocated before a Select Committee, and so far that principle gained ground that it was now accepted by two, if not three, gentlemen who had been presidents of the Board of Trade. He had drawn up a resolution, not exactly in the terms proposed by Mr. Chance, which he should like to submit.

The Chairman said they could not hear another amendment until the first had been disposed of, but he could speak to it.

Mr. J. S. Watson said he thought the principle should be that of Government buying up the interests of the present canal proprietors, and the State or public authorities might enlarge, maintain, and make efficient routes for inland navigation for the use of the public, on the payment of way-tolls. Main routes, such as from London to Liverpool, and from the Humber to the Bristol Channel, must eventually be State affairs, for it would be most difficult to get the different interests involved in the different townships to unite together in one proposal for a through route, and these distances would be rather too long to be conveniently managed by one representative trust. If the main routes were undertaken by the State, and the bye-routes and branches by public authorities, in the interests of their own localities, the matter would be much better dealt with.

Mr. Bantock said he agreed with the proposition rather than the amendment. The remarks of Mr. Adamson were conclusive with regard to the wisdom of the proposition. His experience with regard to a larger expenditure of money than was contemplated for any of the new canal schemes for uniting

canals, which were likely to be before the country, must give great weight to his remarks. He was with the Conference, and with everyone who wished to advance the interests of the country, which were largely dependent on the carrying trade, and he recognised at once that anything which would secure cheapness of transit to all parts must be an immense boon. But it must be done in a sensible way; they must not build castles in the air. The canal companies had, perhaps, not built enough castles; they had been slow and sleepy, and if they had not been paralysed by the new power that had come in, they would to-day have been in far better form. Several years ago Mr. Lloyd had made valuable suggestions to the canal companies, of which they had not availed themselves. Why, then, should they go whining to Parliament, and to local authorities, to help them over the difficulty to which they had not put their own hands? The period was long past when they could ever accomplish as much as they ought to have done, because the railway power was now so great that the very power of the canals was largely injured, but they would do canals no good by ignoring the railways. It was said that the canals would claim the heavy and slow traffic, and the railways were to have all the rest, the passengers, parcels, mails, and so on; 65 per cent. of the traffic carried on a railway he was connected with was minerals, and it could not be said there was no profit in it. The Taff Vale had paid 15 per cent., from minerals chiefly. They had waited until the railways had covered the whole surface of the country, and now they could not displace them. There was one colliery district—Cannock Chase—which had its coal-pits on the rails, and, practically, the whole of the coal was carried by railway. The canals did not take the coal, for there was little canal traffic, except locally, to South Staffordshire and Birmingham. Supposing a million of tons came up to London by canal; when they came to the City Basin could they compete with the railways which had stations at every point round London? The only way was to depend on public opinion for commercial support, and doing everything which could be done in the way of canal development by private enterprise. It was unjust that the capital of £800,000,000 which had been spent on railways should not be considered before the State took up a competitive commercial system, and supported it at the expense of local ratepayers, or with national money. That was a principle he protested against. All great things done in England were done on the principle of self-help by the people themselves.

Mr. Robinson, M.P., said as a member for the city from which Mr. Chance came he begged to support the amendment, because it proposed that they should take immediate action, and suggested to the Government that they should consider the taking over of the canals by the State, and also that provision should be made in the Bill now before Parliament that local authorities might form public trusts where it was thought desirable. If those trusts were formed it was necessary that they should have the sole voice in the matter. As Mr. Chance said, it would be subject to the approval of the Board of Trade under the Provisional Order to be sanctioned by Parliament; and before that sanction was given a very good case would have to be made out. The great advantage of canals being taken by the State was that the State could find money at 3 per cent., whilst many canal companies had to pay 5. Even that difference would give a considerable profit to the undertaking, and would allow of rates being reduced. They all knew how important it was that through rates from London to the Severn should be reduced. He knew of one case in which the provision of the Act of Parliament had been evaded by the officers of a large railway company buying up the majority of the shares in a canal company, and thus getting control of the canal.

The amendment was put, and carried by a considerable majority. It was then carried as a substantive resolution.

THE IMPROVEMENT OF THE WATER COMMUNICATION BETWEEN LONDON AND BIRMINGHAM.

By Henry John Marten,
M.Inst.C.E., &c.

In the summer and autumn of 1885, a committee was formed for taking this question into consideration. The committee consisted of members of the iron and coal trade associations of the South Staffordshire and East Worcestershire mining districts, and of members of several of the Chambers of Commerce and of other commercial associations in those districts, who were specially elected by the bodies named to represent the important and varied interests of their commercial constituents.

The committee did the writer the honour to instruct him to make an inspection of the canals forming the waterway between London and Birmingham, and to report to them "on the question of improving their carrying capacity, and by that and other means of lessening the cost of the transit of goods by water between those places."

The canals forming the waterway between London and Birmingham are as follows:—

	Miles.
1. The Grand Junction Canal, between Brentford and Braunston	92
2. The Oxford Canal, between Braunston and Napton	5½
3. The Warwick and Napton Canal, between those places	13½
4. The Warwick and Birmingham Canal	21½
	132½
Also the Paddington Arm of the Grand Junction Canal	13½
	146

The canal companies were good enough to furnish the writer with accurate maps of their respective canals, and afforded him every facility for making a thorough inspection of them. In addition, he had between 400 and 500 cross sections of the canals prepared, so as to have an accurate record of their existing dimensions at all parts of the system.

Having obtained this information, the next question requiring consideration was as to how and in what way the system could be best improved, having regard both to efficiency and economy.

Size of Existing and Proposed Locks.

The writer found the locks on the Grand Junction Canal to be 14 ft. 6 in. wide, and of a length sufficient to admit a barge 70 feet in length and 14 feet beam, or two ordinary canal boats, lying side by side, of 7 feet beam each, with a depth of 5 ft. 6 in. on their upper, and 4 ft. 6 in. on their lower sills. On the other canals, the locks are only of sufficient width and length to admit of one ordinary canal boat of 7 feet beam entering at a time, the depth over the lower and upper sills being 4 ft. 6 in.

The throttling of the water-borne traffic, occasioned by each boat having to pass singly through these narrow locks, has been, and is now, one of the most material drawbacks to the free development of through water-borne traffic.

In further investigating the question of the size of the lock to be recommended, the writer found that there are between 10,000 and 11,000 narrow canal boats in active service on the canals intersecting the South Staffordshire and East Worcestershire districts previously referred to, moving a traffic of about 7,000,000 tons per annum. Having regard to this circumstance, it became evident that any new lock must be such as should utilise the very large capital invested in this description of craft, and after careful consideration of all the facts of the case, he came to the conclusion that a lock 160 feet in length, 14 feet 6 inches in width, and with 7 feet of water over the sills, would practically be best adapted to the requirements of the traffic between London and Birmingham.

Locks of this description would be twice the length and twice the breadth, and consequently four times the size of the existing narrow locks on the Oxford and Warwick Canals, and double the capacity of those on the Grand Junction Canal.

These locks will pass therefore four ordinary narrow canal boats at one locking; say a cargo carrying steam tug and three butty boats, or 130 tons of cargo at one time in four bottoms. Or two barges (one a steam cargo carrying barge) carrying 140 tons in two bottoms. Or steam cargo carrying vessel, carrying 140 to 150 tons in one bottom.

Dimensions of Improved Canal.

Having arrived at the size of lock to be recommended, the dimensions of the improved canal should be as under:—

		Feet
Minimum top width	....	45
do. bottom	....	21
do. depth	....	8

with side walling 3 feet deep below top level on the towing path side of the canal.

As to Providing a Navigation Large Enough for Coasters of 250 tons Burden.

The writer found that the physical and economical difficulties in the way of enlarging the canals to meet such a requirement would be very great, so much so that the outlay would be more than the traffic would bear. In addition to deepening and widening the canals throughout their whole length between London and Birmingham, it was proposed to do away with 132 awkward bends, and to make 44 deviations, which, in the aggregate, would effect a considerable saving of time and distance.

Reduction in Number of Locks, &c.

By means of lifts and compound locks, it was also proposed to reduce the number from 154 to 90, and in the event of a suggested new route being adopted, so as to avoid the

depression in crossing the valley of the Avon, at Warwick, a further reduction of their number to 75. It was estimated that these improvements would reduce the time of transit between London and Birmingham 12 hours, and that by the facility they would afford for the passage of steam-tugged trains of boats, the cost of haulage would be reduced nearly one-half.

Carrying Capacity and Estimate of Cost.

The carrying capacity of the improved canal was estimated at 2,000,000 tons a year, and the cost of the improvements at £1,250,000.

This outlay was proposed to be provided—

1. By the canal companies interested themselves agreeing to raise the requisite funds, and to make the proposed improvements themselves.

2. By the formation of a new company to take over the existing companies, and for the new company to carry out the improvements.

3. By the creation of a Public Trust.

This latter course commended itself to the committee, and having satisfied themselves of the commercial advantages of the proposed improvements, they have pressed the proposal upon the attention of the local authorities, by whom it is under consideration, and some of whom are taking up the subject with considerable earnestness, and no doubt the recent important Parliamentary utterances, by leaders of eminence of the political parties, will give an important stimulus towards the practical solution of the great question of improving the water communications throughout the country, and of thereby materially cheapening the cost of transit.

THE CAPABILITIES OF THE RIVER SEVERN AS AN INLAND NAVIGATION.

By Henry John Marten,

Engineer to the Severn Commissioners, M.Inst.C.E., &c.

The River Severn, which has a drainage area almost equal to that of the Thames, was practically left in a state of nature up to the year 1842, when an Act of Parliament was obtained, appointing a body of Commissioners to be elected by various county and municipal authorities interested in the navigation, and with ample powers for improving it from Gloucester to a short distance above the town of Stourport, situate 12 miles above Worcester.

The proposal submitted to Parliament was for canalising the whole of that portion of the river, 42 miles in length, by the construction of locks and weirs at suitable places along the course. Great fears were, however, expressed lest the weirs should aggravate the floods, and in consequence, under that Act, Parliament only permitted the Commissioners to canalise that portion of the river which lies between Worcester and Stourport, and for which purpose they were authorised to construct four locks and weirs, and were directed to improve the bed of the river between Worcester and Gloucester by dredging.

A large but useless expense was thus incurred; and no damage having arisen from the weirs constructed above Worcester, the Commissioners applied to Parliament, in 1853, for power to construct a weir and lock near Tewkesbury, about half way between Worcester and Gloucester.

This lock and weir were finished in 1858, and proving of great advantage to the trade, a further application was made to Parliament in the Session 1868-9, when powers were granted to the Commissioners to erect two weirs and locks near Gloucester, by which the complete canalization of the river was effected between that place and Stourport.

The minimum low summer depth over the shoals is nowhere less than six feet, and vessels of 150 tons burthen have navigated the whole distance from Gloucester to Stourport.

Although certain rock shoals restrict the navigating depth of the river in the summer to 6 feet, the depth of water over the sills of the locks between Gloucester and Worcester is over 9 feet, and out of the whole length of 42 miles of canalised river, 30 miles are upwards of, and in some places considerably more than, 9 feet in depth, whilst the average depth of the remaining 12 miles is 7 feet 8 inches at low summer level.

With a comparatively small amount of dredging, therefore, vessels of from 300 to 500 tons burthen might easily navigate to Stourport, a point in the very heart of the kingdom, and within 30 miles of the centre of the South Staffordshire and East Worcestershire coal and iron districts, with all their immense industries, and a population of upwards of a million persons.

At Gloucester, the navigation is connected with the Gloucester and Berkeley Ship Canal, by which vessels of large tonnage are brought to Gloucester. This ship canal has a depth of 15 feet, and is, therefore, capable of being

navigated by any vessels likely to pass from it on to the Severn. The present traffic on the Severn is about 1,000 tons a day. Its principal traffic-feeders are—the before-mentioned Gloucester and Berkeley Canal, the Worcester and Birmingham Canal, the Droitwich Canal, and the Staffordshire and Worcestershire Canal. These three last-named canals are of comparatively small section, and are, in many ways, capable of considerable improvement.

Careful consideration has recently been given to their improvement, and valuable reports have been prepared, and submitted to those interested in the great question of improving our inland navigations.

Above Stourport, the Severn still remains in a state of nature, so that only under favourable circumstances, and with a fair amount of freshet in the river, is it possible to move traffic—and then only to a limited and uncertain extent. The river, at a comparatively small expense, could be canalised as far as to Iron Bridge, which is the centre of the Shropshire coal and iron district, and plans and sections of the river have been prepared with that object.

The traffic on the Severn is principally carried on by means of steam-tugs, towing-trains, or fleets of barges and canal boats. The average number of boats attached to one tug is from 10 to 12, though one tug has sometimes pulled after it a train of 27 loaded vessels, carrying altogether upwards of a 1,000 tons of goods. A train such as that is altogether about three-quarters of a mile in length, and forms a singular spectacle.

Considerable improvements have recently been introduced in the tugs, by which a large economy of fuel has been brought about, and the haulage is very cheaply performed.

The tolls on the Severn are ½d. per ton per mile between Stourport and Worcester, and ⅛d. per ton between Worcester and Gloucester; for the whole distance they average a little under ⅓d. per ton per mile.

Whilst, no doubt, a great deal has been accomplished in the way of improving the Severn, a great deal still remains to be done to make its capacity for usefulness equal to its capabilities.

KENNET AND AVON CANAL.

By H. Gerrish.

This navigation starts from the Port of Bristol, and runs to Bath, Dundas (for the Somersetshire Coal Canal), Bradford-on-Avon, Semington (for the Wilts and Berks Canal), Devizes, Honeystreet, Pewsey, Burbage, Hungerford, Newbury, Reading, where it joins the Thames for Henley, Marlow, Maidenhead, Windsor, Staines, London. The distance from Bristol to Bath is 15 miles, from Bath to Newbury 57 miles, from Newbury to Reading 18½ miles, from Reading to London 74 miles.

The River Avon, from Bristol to Bath, will admit of barges being worked carrying 90 tons when the water is high, but in low water this weight would be reduced to 50 or 60 tons, in consequence of the want of cleansing and dredging. This part of the navigation is under an Act of Parliament, 10 Queen Anne, 1711, and is to be free and open for ever upon payment of toll.

The Canal from Bath to Newbury (under an Act of Parliament of George III.) has been constructed for vessels drawing five feet of water, measuring 14 feet wide, and according to the present soundings on the Lock-sills.

Vessels of that draught ought now to navigate the canal, but they are not able to do so from the great accumulation of mud in the canal, which is seldom less than one foot in thickness, and generally two feet or more. This not only prevents the barges from using the canal from carrying full cargoes, but necessitates the employment of extra towing power. One horse would tow a barge 2 to 2½ miles an hour, if the canal were kept in proper working order; at the present time two or more horses are required to do what ought only to be the work of one. Many of the lay byes throughout the canal were originally made to enable vessels to turn; nearly all these are now of no use, owing to their being full of mud and weeds, consequently barges have often to go long distances beyond their proper destination in order to turn. Owing to the accumulation of mud on the sides of the canal, barges can only pass one another with great difficulty, causing much loss of time. The gearing of the paddles of most of the locks is very insufficient and out of repair. On all properly managed navigations, dredgers are kept almost constantly at work cleansing out the mud, which rapidly accumulates, but on this canal there is none. The only men employed on the canal are a few labourers to clean out the weeds with rakes, which are deposited on the towing-paths, and allowed to remain for months, thus obstructing the use of the paths. The pounds between the locks at Devizes are nearly all full of mud

and weeds; those between the locks at Bath are in the same state, and have been, or are being, filled with earth to make land for building or other purposes. These pounds are used on canals to receive the water flowing from the locks when they are being emptied, so that it may be stored until required for the next lower lock. When these pounds are not kept their proper size and depth, the water flows at once over the waste weirs, and is of no use to the next lock. This is the case now in many of the pounds of the Kennet and Avon Canal. Taking into consideration the extra cost of haulage, caused by the insufficient depth of the canal, the great waste of time, and the diminished cargoes that can only now be carried, much loss is occasioned to the traders on the navigation.

Clause 94, in the Canal Act of Parliament, states that vessels laden with hay, straw, or corn in the straw, or with any kind of manure, &c., are not to pass the locks except when water shall flow over the waste weir of such locks. The water at the top of the Bath locks has been purposely kept one foot below the waste weir, and below the waste weir of the top of the Devizes locks one and a half feet.

If this navigation were kept in a proper state, according to the plans and legal requirements, vessels would be able to carry cargoes at a profit, and without change from any of the towns through which it runs, to Bristol, and thence to Cardiff, Newport, Lydney, Gloucester, Bridgewater, or *vice versâ*.

The Somersetshire Coal Canal runs from Dundas to Midford (from Midford a tramway to the Radstock collieries was formerly used, but this has been sold to the Somerset and Dorset Railway Company), Dunkerton, and Camerton and Timsbury collieries. From these collieries alone coal could be sent over this canal to the extent of 1,000 to 2,000 tons per week if the traders had proper facilities, such as a low toll, the navigation thoroughly cleared and cleansed, and the Parliamentary depth of water to enable them to carry full loads, viz., 35 tons. This is a boat canal only, and in its present state the boats can only carry about 25 tons, and then with more than ordinary power and less speed.

The Wilts and Berks Canal runs from Semington, through Melksham, Chippenham, Calne, Swindon, and other places, to Abingdon, where it joins the Thames. This canal, like the last, is made for boats which carry 35 tons. From Swindon there is a branch running to the Thames and Severn Canal, at Cerney. Traders who formerly used these canals have discontinued the coal traffic, in consequence of their inability to carry full cargoes.

If these canals were taken over by an influential body, and put into good repair, and the traders encouraged to work with steam, using the Willans patent fast-speed engines, which act direct on the screw-shaft, or other engines similar to these—as well as with horse-power, it would be a great benefit to the towns and districts through which they pass, and, after the lapse of a few years, would be returned a good per-centage on the outlay. A fair competition would also be maintained with the rates charged by the railway companies for the carriage of minerals, merchandise, and other goods.

A SHORT DESCRIPTION OF THE RIVER WEAVER NAVIGATION.

By J. A. Saner.

The River Weaver was at one time an insignificant, tortuous, and somewhat brackish stream, running through the centre of Cheshire, but has now, by the unflagging energy of its trustees, been converted into one of the finest inland non-tidal waterways in the kingdom. It rises at Ridley Pool, in the Peckferton Hills, in the south-west corner of Cheshire, and after passing through the chief salt-bearing district of the country, centred in the towns of Winsford and Northwich, empties itself in the Mersey estuary at Weston Point, about a mile and a half below Runcorn.

There are several small tributaries; the most important, the Dane, rises in the Derbyshire Hills, very near the boundary of the countries, and after receiving the Wheelock, near Middlewich, joins the Weaver at Northwich. Its total length is about forty miles, no part of which is navigable.

The area of the water-shed of the Weaver proper is 406 square miles, and that of the Dane 138 square miles, giving a total of 544 square miles, or nearly one half the area of the county of Cheshire. The length of the navigation is twenty miles, the other thirty being little more than a stream.

The first Act of Parliament for making the river navigable was obtained by three Cheshire gentlemen in the year 1721. It was then granted to be made with a depth not exceeding 4 ft. 6 in., and it was only possible to enter at high water ordinary spring tides, the boats

being only able to carry from 40 to 50 tons. At this time the locks were built of timber, with small weirs by the side.

About the year 1760, the navigation was carried down so as to enable vessels at nearly all tides to enter, and in 1810 the river was further improved by the Weston Canal, which is four miles long, enabling vessels of much deeper draught to enter without navigating a dangerous part of the old river. This canal forms a junction with the Bridgewater Docks at Weston Point, and a dock was formed in connection with it so as to enable vessels to wait for the tide.

In 1830 the depth was increased to 7 ft. 6 in., with the locks 88 feet long and 18 feet wide, capable of taking cargoes of 100 to 150 tons. There were at this time 11 single locks on the river, not including the entrances to the Mersey. About 1860, a second set of locks, having 10 feet of water on the sills, and 100 feet long by 22 feet wide, was placed by the side of the existing locks, and the number reduced to nine pairs. The larger size, owing to the vessels being built almost to the shape of the lock, were capable of passing vessels with nearly 320 tons on board.

This state continued until about fourteen years ago, when it was decided to replace these locks by some of very much larger dimensions, and also to greatly reduce the number. With this object, locks were built at Dutton and Saltersford near the site of existing locks, and of sufficient height of walls to enable the two ponds above to be thrown into one, thus doing away with the four smaller locks. The same has been done at Hunts, and is now being done at Valeroyal, above Northwich. Those at Dutton and Saltersford are entirely built of masonry, having limestone sills and rubbing courses, with the intermediate part sandstone. All the work on the river is of this description, with the exception of Hunts and Valeroyal large locks; these are built of concrete, with masonry quoins, &c., up to the water level, and then faced with sandstone, ashlar, and limestone courses as before.

When these improvements are completed, there will be only four locks on the twenty miles of navigation, the larger of each pair of locks being 220 feet long, by 42 ft. 6 in. wide, and having 15 feet of water on the sills. Most of the river is now dredged to 12 feet, there only being ten-feet bars at certain points. The ordinary width is about 95 to 100 feet at water level, and 45 feet at the bottom.

The new locks just mentioned are capable of taking a steam-flat, towing three barges, and carrying say 250 tons each, or 1,000 tons of cargo at one locking. The gates are worked by turbine power, and the lock filled and emptied by cylindrical equilibrium sluices, the time taken being about six or seven minutes, or say a total of ten minutes from entering to leaving the lock.

The total lift from Weston Point to Winsford is 37 ft. 6 in., made up of 9 ft. 6 in., 7 ft. 4 in., 11 ft. 2 in., and 9 ft. 6 in. lifts respectively.

At the entrances to the Mersey there are now docks, having entrances of equal width to the other locks, with sills capable of taking vessels of 15 feet draught at the lowest tides on the Mersey; in fact, they are too low at present for the Mersey channels, and are far in advance of that river in point of navigable facilities. The docks are fitted with storage wharves, and rapid hydraulic cranes, for small weights of 30 cwts., and hand and steam-power cranes for heavier weights.

At Anderton, about 12 miles from Weston Point, the river runs very close to the Trent and Mersey Canal, and here is one of the most interesting works upon the navigation. The total difference of level from the river to the canal is 50 ft. 4 in., and is accomplished by means of a double hydraulic lift, capable of lifting or lowering boats and cargo in bulk, complete from one navigation to the other. This lift is fully described in the "Institution of Civil Engineers' Proceedings," vol. 45, but it may be as well here to give a few of the leading particulars. The full length of the trough is 75 feet, the width 15 ft. 6 in., and the depth of water 5 feet. The total weight of the water and trough is 240 tons, and this is balanced on a single ram of 3 feet diameter; there are two caissons or troughs of equal weight and dimensions, and when the valves are opened they exactly balance one another. One caisson is always kept up, and the other down, except from Saturday to Monday.

The lift is worked by simply putting more water in the top caisson than in the bottom, an arrangement of syphons ensuring that although the water in the top caisson is 5 feet, there is only 4 ft. 6 in. in the bottom. An accumulator just commencing and finishing the stroke, the remainder, or full $\frac{11}{12}$ ths, being performed without extraneous aid.

In the contract it was stipulated that the lift was to be performed in three minutes; it has been done in about two minutes and a half, and by increasing the quantity of water taken

from the canal, it could be effected more speedily even than this.

Besides being worked as a double lift, each trough can be lifted separately by the engine and accumulator, but this is a comparatively slow operation, and occupies about half an hour. With ordinary care, no accident can happen to the apparatus from frost, as all the exposed pipes are protected with felt, and at night it can be entirely emptied of water by opening two little valves, placed on the lowest exposed parts. It will be understood that the motive power for working this lift is of two kinds. The first part, and in fact quite $\frac{11}{12}$ths of the entire lift, is performed by taking a layer of water 6 inches deep over the surface of the upper trough, that is to say, a weight of 15 tons from the canal, and the remaining $\frac{1}{12}$th is performed by a small engine continually pumping water into an accumulator. The obvious advantages in having the lift double, so that it can be worked as described, are the saving of engine power and time.

A single lift could only take two barges up or bring two down in eight minutes, so that sixteen minutes would in this case elapse between the commencement of each lift. In the double lift, each press, with its trough, is in turn an accumulator to the others, and does its own useful work of lifting and lowering.

This lift when erected was the only one of its kind; two are now being built in France and Belgium to lift 770 tons and 1,100 tons, the latest being described in *Engineering* for February 24th, 1888.

The burdens of the smaller boats, called "narrow boats," using this lift are from 30 to 40 tons, and those locally known as "dukers" carry from 80 to 100 tons.

The other works on the river, although of great importance for the navigation, are not so intimately connected with it; these are the sluices for passing flood water. On all navigations and canalised rivers liable to floods, the great difficulty is to be able to pass away the water without impeding the traffic, and without flooding the surrounding country. This has been accomplished on the Weaver to a very great extent by means of what are, practically, moveable weirs, at Dutton, Saltersford, and Hunts, and now in course of construction at Valeroyal. They are flood-gates, or sluices, capable of being lifted clear of the water, thus allowing an uninterrupted passage (from designs by Mr. L. B. Wells, M.I.C.E.), and consist essentialy of doors 15 feet by 14 feet deep, built of rolled iron beams with timber sheathing. These are supported by masonry piers, and are lifted by means of overhead gearing, so that the attendants are entirely above water and on a permanent bridge. Friction is practically dispensed with owing to their working on rollers. The rollers hold the doors from their seating, and would thus allow the passage of the water. To prevent this, "stopwaters" have been introduced, consisting of pieces of hard wood weighted at one end, until the specific gravity is about the same as that of water; they then float vertically, and are held in such a position that the pressure of the water forces them into the angle formed between the door and the masonry.

Since the adoption of this plan of sluice the flood level at Northwich has been practically reduced by one-half, and instead of having floods of 8 to 12 feet, the highest there has ever been since their erection is 6 feet, and portions of the river valley which were continually under water do not now suffer at all.

The quick discharge of floods is greatly facilitated by having a system of rain gauges at different places in the watershed. The persons in charge of these gauges send word by telegram to the head office when more than $\frac{1}{2}$ inch of rain has fallen in the 24 hours. It is then in the power of the engineer to use his judgment, and if necessary, by means of the telephone, with which the office is connected to every weir, to give orders to the attendants as to the amount of sluice to be raised. By this means the river can be prepared for a flood by the water being drawn below the usual level beforehand, thus making room for the first flush of flood-water. In one or two cases the river has been drawn down something like six inches before there was any appearance of extra water.

The river, from an economical and commercial point of view, is quite as, if not more, interesting than from an engineering point of view. The controlling body consists of 105 gentlemen chosen from the county of Cheshire, who form a self-elected body of trustees. The chairman is Colonel France Hayhurst. The meetings are held at Northwich every two months; a finance and works committee every month, with an annual inspection and meeting. The post of trustee is entirely an honorary one.

The present annual income is about £60,000, any surplus over expenditure goes to the county of Chester for the relief of the rates. The amount thus handed over to the county

has been £15,000 annually for the last three years, and £10,000 for the preceding three years.

The staple industry at present served by the river is the salt trade, about 1,000,000 tons being carried down every year. The salt is carried in bulk or bags according to the quality, by either steam or sailing "flats," each carrying from about 70 to 320 tons. These flats are at present not larger than 88 + 22 + 10 feet, one steamer towing three others in train. There are not many records of the time taken, but the following will give a fair idea of the immense improvements which have been effected. In 1878 it took a train of boats 9 hours 6 minutes from Newbridge to Weston, a distance of 18 miles, while in 1885, it took the *same* boat, towing almost an equal tonnage, only 7 hours 1 minute. It is scarcely fair to take the above comparison, because although the river was improved below Northwich, the upper improvements are not finished yet. Taking the time from Northwich to Weston, in 1878 it took 6 hours 24 minutes, while in 1885 it only took 4 hours 38 minutes, the latter including a delay of 10 minutes. In 1878 there were four locks to pass through, in 1885 only two.

Trade.

The statistics of the salt sent down the river are published monthly and annually, but it may be as well to quote them here. In 1732, 9,322 tons rock salt, and 5,202 tons white; in 1880, 115,496 tons rock salt, and 1,087,214 tons white. About 500,000 tons are also sent by rail, but this does not affect the river. Although, as above stated, salt is the most important trade on the river, it is by no means the only one. A large traffic in china clay, stone flints, bones and bone-ash, &c., for the Staffordshire Potteries, *viâ* the Anderton lift. The chemical trade is well represented on the banks, and sends something like 120,000 tons annually down the river.

There are now 265 vessels trading on the river, of which 65 are steamers, the canal-boats not being counted. These make about 150 trips per week, or 25 per day, carrying a gross tonnage of 1,300,000 tons per annum.

Rates.

The rates on the river are, for the facility given, very low. No charge is made for dock dues on vessels using the river, and vessels are towed up the Mersey free of cost. The river dues are as follows:—

White salt......	1/-	per ton of	20	cwts.
Rock ,, ...	6d.	,,	24	,,
Coal ,, ...	6d.	,,	30	,,
Merchants' goods	8d.	,,	20	,,
Pottery ,,	8d.	,,	20	,,
Stone ,,	2d.	,,	20	,,
Cinders	1d.	,,	20	,,
Flags	10d.	,,	20	,,
Purple ore	6d.	,,	20	,,
Gravel..........	1d.	,,	20	,,

It will be impossible to bring this very short and incomplete account of the Weaver to a conclusion without mentioning how greatly the Weaver will be benefited by the Manchester Ship Canal when finished. The river, as before stated, is far in advance of the Mersey at present, but when the canal is made with deep water to Eastham, vessels using the river will be able to enter and leave it any state of the tide, and at all times. This is shown by the fact that, in the year 1883, although the docks at Weston are deep enough to take vessels drawing 15 feet of water at any tide, there were only 146 tides in which such vessels could have got up the Mersey.

The river as it now is certainly shows what may be done by perseverance and good management, the original 4 ft. 6 in. being now turned into 10 feet, and the eleven locks, only capable of passing canal boats, into four locks of dimensions sufficient to take coasters. It is impossible to look upon this river without coming to the conclusion that a self-elected body of trustees, if they only do their work thoroughly well, is far the best description of corporation for managing such a large concern, the whole history of the Weaver having been one of continual progress since the first Act of 1721.

Miscellaneous.

CONNECTION BETWEEN INDIAN ART AND COMMERCE.

The following remarks on this subject by Sir George Birdwood were made in the discussion on Sir William W. Hunter's paper before the Colonial Institute, "The New Industrial Era in India," on May 8:—I must explain that my forthcoming work, to which Sir W. W. Hunter has so kindly referred, treats of the ancient commerce of India only in so far as it throws light on the sources of the origin of Indian art. Before the discoveries of Botta and Layard at Nimrud (Calah), Khorsabad (Dar Sar-

gina), and Koyunjik (Nineveh), we could trace back the line of the development of Greek art Eastward to a certain point, and then there was a void; and we could trace back the line of the development of ancient Hindu art Westward to a certain point, and again there was a void. But now, after the exhibition that has been opened to us by the exhumation of the palaces of Assur-nazir-pal (Nimrud), and Sargon (Khorsabad), and Sennacherib (Koyunjik), of the arts of Mesopotamia in the eighth and ninth centuries B.C., we see at a glance that this country was the common centre of origin of the arts of both Greece and India; and it was through the seaborne commerce of the Phœnicians, and the overland commerce of the Hittites between Nineveh and Ionia, that the arts of Assyria were carried Westward, at the critical moment of the nascence of Hellenic nationality; and through the commerce of the Babylonians that they were carried Eastward into all the countries of the Indian Ocean. Not only the arts, but the whole civilisation and culture of the Old World were, and have ever since remained, profoundly affected by commerce of the East and West with Mesopotamia during the period of the Sargonids of Nineveh, and the immediately subsequent period of the supremacy of Babylon under Nebuchadnezzar III. (B.C. 605-562). Almost contemporaneously with Nebuchadnezzar, the enlightened commercial policy pursued in Egypt by Psammetichus I. succeeded at last in uniting in one general organisation the commerce previously carried on independently in the Mediterranean Sea and the Indian Ocean. It was thus that the Indian drugs, which still hold the chief place in the pharmacopæias of Europe, first found their way from the East into the West; and that the Egyptian doctrice of the transmigration of souls, and the Chaldæan system of astronomy were introduced into India. More than this. The Israelites taken into captivity by Shalmaneser IV., and Sargon, and Esarhaddon, became scattered over all Media and Persia, while the Jews who were transported by Nebuchadnezzar into Babylonia, there gradually obtained the mastery of the international commerce developed by the Babylonians, through nearly 2,000 years, besween Mesopotamia and Central and Southern Asia on the one side, and Anterior Asia and Greece, and Italy and Northern Africa on the other; and in this way the religious and moral teachings of the Jews were carried over the whole of the Old World known to antiquity. The old ethnic religious ideas of the Pagan nations then participating in the trade with Mesopotamia in turn reacted on Judaism, and thus, while Hinduism in India became internationalised as Buddhism, Judaism became internationalised, wherever it was propagated through Hellenic agencies, as Christianity, and wherever it was not influenced by Hellenism, as Mahomedanism. We worship God as the one only deity, and under His Hebrew name of Jehovah, entirely through the wide vogue and authority given to the religion of the Jews in the eighth and seventh centuries B.C., through the cosmopolitan commerce of Mesopotamia. . . . . I certainly fear the effects on India of that country becoming an active participator in the commerce of modern Europe. The whole organisation of society in India —I mean India of the Hindoos—is co-operative, and not competitive, as in Europe. The Hindoos are an Aryan people like ourselves, but located in a tropical climate, in which it is impossible for them to develop their manhood to its fullest physical capabilities, or to maintain themselves at all except under a system of exclusive privilege, such as that secured to them by the Code of Manu. I am satisfied that if once the caste system of the Code of Manu, by which the race of Brahmanical Hindoos has been formed, and which is the true palladium of India of the Hindoos—I am most apprehensive that when it has once been brought into familiar contact with our competitive civilisation, particularly as represented by our ruthlessly aggressive free trade commerce, the most powerful agency through which the universal solvent of Darwinism (the law of the survival of the strongest not "fittest") is operating on the political developments of our age—I fear it must give way in the unequal struggle, and bring down with it the whole fabric of Hindoo society. Apart from the co-operative caste system, expressly devised for the protection of the weaker against the stronger, the race of Brahmanical Hindoos cannot exist—not in unprotected competition with the English or other European races. We have already had ample experience of the solvent action of free commerce on the social institutions of the people of India. It was the ancient trade with Mesopotamia and Egypt that gradually undermined the caste system of India, and substituted Buddhism in place of Brahmanism. Buddhism was only triumphant in India so long as the trade between the East and West by way of the Persian Gulf and through Egypt prospered, namely, from about 500 B.C. to A.D. 500. When this trade was broken up by the rise of the Mahomedan power in the seventh century A.D., Buddhism, which was internationalised, commercialised Hinduism, at once died out of India, and Hinduism everywhere re-established itself. The remarkable anti-commercial spirit of the Code of Manu, as it was finally revised during the decline of Buddhism, clearly betrays the dread of the Brahmanical priesthood of the disintegrating action of the foreign trade of the time on Hindu society. The Brahmans are in the same fear of the evil consequences of the modern European trade with India. Some years ago I published, in the *Times*, some popular native ballads from Western India, giving the most pathetic expression to Brahmanical anxieties on that point. I confess—considering the debt India is under to the genius of the Brahmans—that I deeply sympathise with them, and to the fullest extent share in their anxieties. As an Englishman, I accept free trade—the most tremendous weapon of Imperial dominion with which an ethnically

powerful people could arm itself; but, were I a Brahman—one of the race that had made the India of the Hindoos, the India of a continuous history in literature and art of 3,000 years—if I could not resist it I should be driven to cry out in despair, "Finis Indiæ."

AGRICULTURE IN WESTERN AFRICA.

The staple products of West African agriculture are plantains, yams, sweet potatoes, beans, maize, ground nuts, and cassava (cassada). In localities where rain is uncertain, as, for instance, on the Cameroon Mountains, the people bend down the large broad leaves of the plantain to catch the dew, and wring out the moisture from the succulent stem of that valuable plant. In Akim the natives are very partial to palm oil (which, however, they are too lazy to cultivate), taking it in the form of soup, with snails or monkey-flesh. Their ordinary dish is called *foufou*, and consists of green plantains, boiled and beaten to a pulp by a bough in the hollow of a cotton tree (*Bombax*), a little cold water being mixed with them. Of this they consume enormous quantities, after which they frequently fast for 24 hours. They sometimes roast the plantains over a wood fire. In the lowlands of the Cameroons a sort of cassava pudding is made by tying the grated cassava pulp in plantain leaves and boiling it.

In most localities the guava, mango, papaw, and pineapple grow in profusion, bnt are little cultivated or cared for. A curious product of the West African forests is the *dika* or *odika* bread, or "Gaboon chocolate," afforded by the seeds (*oba*) of the *ibo* tree (*Irvingia barteri*). The plums are gathered as they fall from the tree, and are emptied from the baskets one after another till a large heap is formed. Here they are allowed to remain many days until the outside has putrefied; then the nuts are cracked, and the kernels are taken out and smoked for some days. Next they are put into a large mortar, and crushed into a homogeneous mass. This is exposed to the rays of the sun, which causes the fatty portion to melt and separate. Moulded into cakes, it will keep good for six months. The natives eat it as a flavouring ingredient with their cooked plantains. Its percentage composition has been stated as follows:—5 water, 9½ protein, 65½ fat, 10 starch, 3 cellulose, 2½ gum, 4½ ash. Dika fat resembles cacao butter.

Palm oil, fresh from the nut, is an important item in the negro dietary, and the so-called "palm-chop," when properly prepared, has received encomiums even from Europeans. The nuts of the oil-palm (*Elæis guineensis*) are about the same size as large chestnuts, the inner part being excessively hard and stony, and containing an almond (technically "palm kernel"). This is enclosed in an outer mass of fibre and pulp, which contains the oil, and is covered with a rich, red-brown skin or husk, a little thinner than that which covers the chestnut. The pulpy oil and fibrous portion having been separated from the nuts, is melted in a pot over the fire, for the purpose of separating the fibres, and is then ready to be added to the remainder of the dish. The whole is next gently stewed with sufficient water till it is done, ground green chillies or capsicums (*Capsicum annuum*), salt, and shallots (or a substitute for the last named, consisting of the dried bark of a tree called *edoo-ah-yew*, which closely resembles the onion in flavour) being added to taste. It is always eaten with farinaceous food, such as a preparation of maize, flour, or cassava. The palm fruits grow in bunches near the top of the tree, and are chiefly gathered or cut about April. The bulk of the produce is exported for soap and candle making.

Perhaps the most important agricultural product of this region is the ground-nut (*Arachis hypogæa*), the *mpinda*, or *ginguba* of the natives. It is a trailing, straggling plant, about two feet high, having the curious habit of curving downwards into the soil as the seed develops, and ripening its fruit underneath the ground. When fully grown, the fruits are 1 to 1½ in. long, dusky yellow in colour, and contain a couple of brownish-red seeds. The plant demands good soil, but requires little cultivation, beyond burning of the weeds, and digging small holes, into which the seeds are dropped. These operations take place in October and November; the first crop of green seeds for eating may be gathered in April, the ripe seeds for export as an oil yielder, in July and August, the whole being simply pulled up and the nuts threshed off. The stems are good fodder. The natives prepare the oil for home use in the following rude manner. The seeds are pounded into a uniform mass, in a wooden mortar; a lump is then taken out, and hot water is poured on it, while it is kneaded in the hands; the oil and water are afterwards separated. The oil is very largely used in culinary operations. The seeds, simply reduced to a paste by being ground on a stone, are employed to thicken stews. The nuts are seldom eaten raw, but roasted in the husks. Thousands of tons of the mature nuts are exported to Europe, where the oil is sold as salad oil, and generally replaces olive oil, inferior grades going to the soapmaker.

Another oleaginous seed, also called ground-nut, but sometimes distinguished as the Bambarra groundnut (*Voandzeia subterranea*), likewise flourishes. Each pod contains a single seed. These seeds are eaten, either raw when fully ripe, or boiled like peas while green. In Angola a beer called *garapa*, or *uallua* is made from germinating maize, sun dried, pounded, mixed with equal quantities of dry mandioca root or cassava (*bala*), boiled, cooled, strained, and fermented. The so-called *shea* or *galam* "butter" is a solid fat obtained from the seeds of a tree found growing wild in the forests. The fruit somewhat resembles a Spanish olive, and is about the size of a pigeon's egg. The kernel is enveloped in a sweet fleshy pulp, under a thin green

rind; it possesses a flavour resembling an over ripe pear, and is esteemed by the natives. The "butter" is extracted from the kernels by boiling, the shells having been first removed by drying in the sun and then cracking them; the "butter" is white, firm, and of richer flavour than genuine cow-butter, besides having the advantage of keeping good for twelve months without salt. It contains a rubber-like substance called "gutta - shea," apparently resembling that afforded by the juice of the bark when wounded. It has appeared in British commerce as a soapmakers' material, for which it is esteemed, the exports at present not exceeding, however, 300 to 500 tons yearly. The supply available is equal to that of palm oil. Finally, coffee is indigenous on the Cameroon mountains, and is being cultivated by the natives in the Portuguese territories; it promises to become an important industry, and the same may be said of cocoa.

In Wassaw, the staple dish is maize, boiled and made into a kind of hasty pudding.

ALGERIAN WINE INDUSTRY.

Her Majesty's Consul at Algiers, in his last report, says that the hearts of Algerian wine growers have recently been gladenned by a circular from the Director-General of French Customs, ordering that no liquors are to be classed as wines which are not the pure juice of the fresh grape, and that all the various substances known in France as *Vins de composition*, *les piquettes alcoolisées*, *Vins doublés*, or wine watered and then strengthened by alcohol, and *Vins de Marc*, are to be excluded from this category. During the first eleven months of 1887 the importation of Algerian wine into France amounted to 687,000 hectolitres, about one-third of the entire production of the colony, and this was a greater quantity than had been sent to France during any previous year. It is stated that general complaints are made that cultivators cannot sell their produce at remunerative prices. They accuse the brokers of combining against them, and many colonists are said to have been compelled to sell at as low prices as fourteen or fifteen francs per hectolitre—hardly more than one penny a bottle—and the wines of Algeria, especially those of the older vineyards, are stated to be of excellent quality, and compare favourably with some of the best *crus* in France. Vine planting in Algeria necessitates an expenditure of from 3,000 to 3,500 francs per hectare (£48 to £56 per acre). The plants do not enter into full bearing before four years. The seasons are uncertain, manure is scarce, and the planter can hardly reckon on more than fifty hectolitres of wine per hectare; notwithstanding this he may, says Consul Playfair, fairly count on a return of from 10 to 20 per cent. on his capital, if he carries on his operations on a sufficiently large scale. In the plains of Constantine, near Böne and Jemmapes, and at Philippeville, a large proportion of the most ordinary wine is produced, valued at from 18 to 22 francs per hectolitre. On the heights above Philippeville, at Duzerville, Randon, Mondovi, Souk Ahras, and Constantine, the quality is superior, and resembles the wine of Macon and Beaujolais; it is valued at from 25 to 30 francs. The Sahel of Algiers produces wine of a much more delicate quality, resembling that of the Rhône, and is worth from 26 to 28 francs—sometimes considerably more. That of Medea and Miliana is still better, and fetches from 57 to 75 francs. In the Province of Oran, the best wines are made at Tlemçen and Mascara, and the white wine of the latter place is exceptionally excellent.

Notes on Books.

The Fundamental Principles of Chemistry Practically Taught By a New Method. By Robert Galloway, M.R.I.A., F.C.S. London: Longmans, Green, and Co.

The author, dissatisfied with the ordinary chemical works intended for beginners by reason of their arrangement and construction, which he considers to be unsuitable for educational purposes, has attempted to teach the principles of chemistry by a new method. He commences with a course of physics suitable for the course of pure chemistry given in the after part of the work. Chapters 1 to 7 deal with matter, molecular attraction, gravitation, ebulition, density, sublimation, and adhesion. With chapter 8 commences the illustrations of chemical affinity, chapter 9 is devoted to different classes of compound substances, chapter 10 to the general laws of chemical combination, chapter 11 to nomenclature and notation, chapter 12 to acids and acid anhydrides, and chapter 13 to salts. Chapter 14 is on the mode of expressing chemical changes, and completes the portion devoted to the study of the language of chemistry.

The Storage of Electrical Energy, and Researches in the Effects created by Currents combining Quantity with High Tension, by Gaston Planté, from 1859 to to 1879. Translated from the French by Paul Bedford Elwell. London: Whittaker and Co.

This volume, containing the result of Mons. Planté's researches for twenty years, is divided into six parts; in the first is a description of the experiments and apparatus for accumulating or transforming the energy of the voltaic battery by means of secondary currents, in the second part is an enumeration of the applications to which these experiments have been put, and of others which might be carried

out. The third part relates to phenomena observed with electric currents of high tension obtained by means described in the first part, and in the fourth the analogies which these effects seem to present with many great natural phenomena are treated of. The fifth part contains a description of the rheostatic machine, and in the sixth there is an enumeration of analogies which electrical phenomena present, with effects produced by mechanical actions, and a statement of the inferences drawn from them as to the nature of electricity. The work is fully illustrated.

General Notes.

PARIS EXHIBITION, 1889.—The Executive Council of the British Section announce that they are prepared to receive applications from intending exhibitors up to the 9th of this month, at which date it will be absolutely necessary to commence the allotment of space. It appears that very little, if any, more space can be given to this country, which already has a large proportion of the amount allotted to foreigners, the demands made by native exhibitors having been unexpectedly large. As regards the Industrial Departments, it is now certain that an excellent representative display will be provided: some of the classes are now practically filled up, though in others there is still room available for allotment. Nearly all the outside space available has been disposed of, so that any exhibitors wishing to show in the open air, or to erect small pavilions for themselves, must apply at once, and it is even now doubtful whether any more can be accommodated. Messrs. Davy, Paxman and Co., of Colchester, have taken the contract for the supply of motive power for the British machinery.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 4...Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Pell, "The County Government Bill."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. C. Nicholson Lailey, "The Acton Main Drainage."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Messrs. B. E. and J. R. Newlands, "Modes of Using Char." 2. Mr. T. T. P. Bruce Warren, "Olive Oil and its Adulterations."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Annual Meeting, and Address by Sir Monier Monier-Williams.

TUESDAY, JUNE 5...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sidney Colvin, "Conventions and Conventionality in Art."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Prof. Amélineau, "Les Actes Aoptes du Martyre de St. Polycarpe." 2. Dr. Bezold, "Remarks on some unpublished cuneiform—syllabaries with respect to prayers and incantations written in interlinear form." 3. Rev. C. J. Ball, "The Khetta-Hattê and their Allies."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. W. Warren, "On Lepidoptera collected by Major Yerbury in Western India in 1886 and 1887." 2. Prof. F. Jeffrey Bell, "Report on a Collection of Echinoderms made at Tuticorin, Madras." 3. Mr. F. E. Beddard, "On the Sternal Gland of a Species of *Didelphys*."

WEDNESDAY, JUNE 6 ... Metropolitan Association for Befriending Young Servants (at the HOUSE OF THE SOCIETY OF ARTS), 2½ p.m.

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. H. Collins, "The Sudbury Copper Deposit (Canada)." 2. Mr. George Attwood, "Notes on some of the Auriferous Tracts of Mysore Province, Southern India." 3. Mr. E. Wilson, "The Durham Salt District." 4. Mr. E. Wethered, "The Occurrence of *Calcisphœræ* in the Carboniferous Limestone of Gloucestershire." 5. Mr. Charles Davison, "Second Note on the Movement of Scree-material."

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Mr. S. W. Williams, "Excavations and Discoveries at Strata Florida Abbey."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

THURSDAY, JUNE 7... Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. R. Warrington, "The Chemical Action of some Micro-organisms." 2. Dr. J. H. Gladstone and Mr. W. Hibbert, "The Optical and Chemical Properties of Caoutchouc."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. T. G. Bonney, "The Growth and Sculpture of the Alps."

Archæological Institution, Oxford-mansions, Oxford-street, W., 4 p.m. 1. Rev. E. S. Dewick, "The Discovery of a supposed Anchorite's Cell at Ongar, Essex." 2. Mr. J. Park Harrison, "Norman Masonry and Mason's Marks."

FRIDAY, JUNE 8...United Service Institute, Whitehall-yard, S.W., 3 p.m. Lieut.-Col. A. R. Savile, "Military Cycling."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Phosphorescence and Ozone."

Astronomical, Burlington-house, W., 8 p.m.

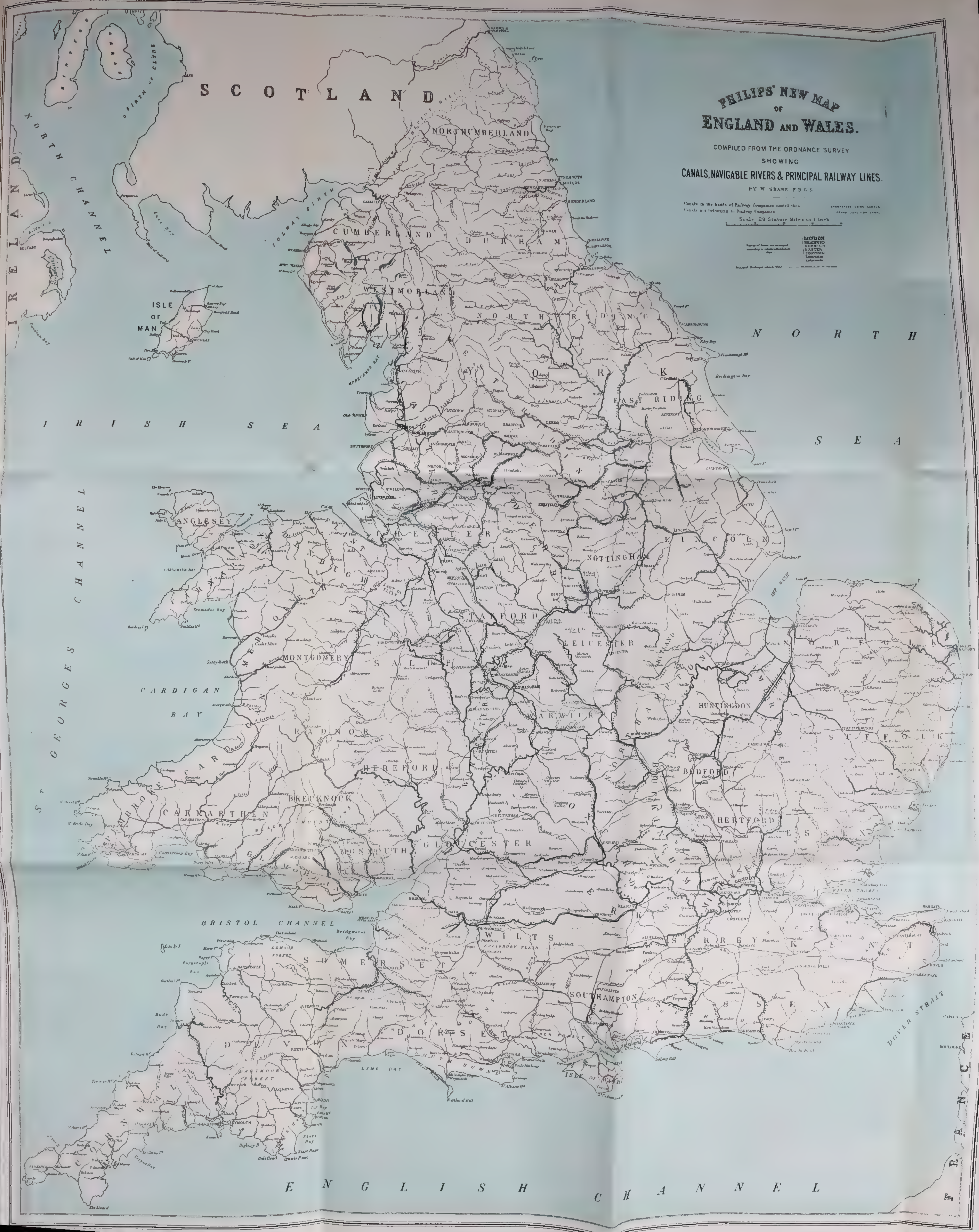
Quekett Microscopical Club, University College, W.C., 8 p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. A. W. Verity, "*Titus Andronicus*."

SATURDAY, JUNE 9...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. J. H. van't Hoff, "The Analogy between Gases and Substances in Dilute Solution." 2. Mr. W. Lant Carpenter, "Exhibition of a Lantern."

Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Count Tolstoi as Novelist and Thinker."



GEORGE PHILIP & SON LONDON & LIVERPOOL

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FRIDAY, JUNE 8, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, June 20th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

As the accommodation for hats, coats, &c., is very limited, members will greatly promote the general convenience by not bringing with them more wraps than are absolutely necessary. A special building has been erected to serve as a cloak-room, but it is of necessity smaller than the court used in former years for the purpose.

Tickets of admission are now in course of issue.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 29, 1888, Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., in the chair.

The paper read was—

PERSIAN TEXTILES.

By Cecil Smith.

The subject of my paper this evening is one which I think needs no apology from me. In the comparative history of the different arts there is probably none which has such strong and such varied claims upon our attention as the history of textile fabrics; though it may be true that of itself it has existed only by reason of its application for purposes purely decorative and useful, and is therefore subordinate to those arts which exist for themselves and are supreme, it is equally true that there is no art which has so ancient a pedigree, or which, in its way, has exercised so powerful an effect upon its sister arts. From the time when the grand old gardener and his wife sewed together their patchwork costume, erring human nature has ever assigned to this the second most important place in its consideration. As a rule, we take thought first of what we shall eat and what we shall drink, and then wherewithal we shall be clothed; I say, as a rule, because I have known cases where the first consideration has been entirely neglected in favour of the second; the study of food and drink being in these cases only a fugitive, though unpleasantly recurring, necessity, while the dress of ourselves and of our neighbours is an interest without fail, and a joy for ever.

Next to that which clothes our body, the most important thing is that which decorates our surroundings; and here we arrive at what is the beginning, if it is not the origin, of all decorative art, other than that of mere personal advancement. Primitive man, we know, decorated his weapons with a rude pattern, probably before he ever thought much about his costume; but whereas the motives and types of other arts can usually be traced to textile art, this seems to work out independently motives for itself, or to go direct to nature in the first place. The theory of Semper, which is generally accepted, is that, in the primitive habitation, walls, pillars, and roofs were certainly hung with textile fabrics before they were carved or painted; and in the subsequent history of sculpture, painting, and architecture, we frequently come upon suggestions and tendencies which have no origin in the connection in which we find them, but which can only be explained by reference to the mother art from which they spring. To take just two instances of what I mean: the so-called tomb of Midas, carved in the natural rock on a mountain side in Phrygia, has the façade decorated with a geometrical pattern which would certainly never have been suggested by the independent use of chisel upon stone; it can only be explained as the imitation of the woven *portière* which, in the East, serves instead of a door, and here forms an imperishable rock carpet, veiling the presence of the dead monarch from the passers by, like the Oriental carpet which stood before the statue of the god in his Greek temple; so here, the dead man is a god, and his sanctuary is hidden from view behind the

carpet of rock.* Or, again, if we look still nearer at home, we have in the British Museum an actual pavement from the palace of the Assyrian king Assurbanipal, carved in stone, with a beautiful carpet pattern, which, both in its shape and in its conventionalised flowers, is directly copied from a woven fabric which must have been intended for the same purpose. One can understand from such cases as these what an influence woven and needlework fabrics may have had in controlling and varying the development of decorative patterns. Easily adapted for transmission, and in universal demand wherever and whenever commerce has followed civilisation, they have, at all times, formed the readiest means of transmitting the artistic ideas of one nation to another.

The origin of all European art, like that of all written history, is to be found in the western portion of Asia, whence successive Aryan migrations have carried it westward. Though it is true that the Greeks of the 7th and 6th centuries before our era were the first people who raised art to an independent growth, and that it was upon Hellenic soil that it may be said to have first taken root and borne fruit, this was only brought about by repeated contact with the flood of Oriental importations which we know to have flowed in upon it at that period; and which, like their own native sunlight, quickened and expanded the germ which was there, giving it warmth, and life, and colour. This is illustrated not only by what we know of the beginnings of Greek art, but also by numerous references in their history, literature, and tradition. The wool of sheep is the first and most important of all materials for clothing; and so we find that the Græco-Phœnician god Herakles is said to have brought sheep from Egypt to Greece, his semi-Phœnician character reflecting what was probably the channel through which these textile importations came, the traffic of the Phœnician merchant-mariner. According to another legend, it was Dionysos who, in his journeying from India, brought sheep thence; and in these two legends we have typified what we know to have been actually the two routes by which Eastern civilisation penetrated to Hellas; on the one hand, it came by sea, following the steps of maritime commerce, which brought its products direct to the seaports of Greece; and on the other hand, in the 7th century B.C., it came by land, when the colonising activity of the Greeks was pushing eastward, when their citizens were founding new towns on the coasts of Asia Minor, and meeting directly the cross-country caravans from the mighty empires of the far inland. The sheep of the East were famous throughout antiquity for their wool; we hear of Polykrates, the tyrant of Samos, in the 6th century, trying to improve the breed of his native flocks by importing others from Miletos, and later still, in the time of the Ptolemies, we read of Arabian sheep being brought into Egypt. All through the early literature we have references to cunningly-contrived marvels of the loom or needle, and always under terms which point to an Oriental origin; nor was it only in the dim pre-historic ages that this was the case. Two of the earliest artists, whose names have come down to us in history, Akesas and Helikon, were weavers of Salamis in Cyprus, an island which at all times has been, as it were, the half-way house of Phœnician trade between East and West; these were the cunning workmen who first made for the patron goddess of Athens the embroidered peplos which was offered by her people at her yearly fête. Moreover, actual remains point unmistakeably in this direction; we have, it is true, no embroideries or robes from Greek tombs so early as this, but we have, in the Greek vases of this period, evidence which leaves no room for doubt. In the 7th century, just at the time when Greek colonists were bringing east and west into direct contact, a great change comes over the Hellenic pottery; the stiff and angular character which may have come from the habits of people accustomed to a tradition of basket-making, and the limited scope of decorations which are open to the graver upon metal, give way to a freer and more florid style; the form of the vases becomes rounder, new colours and subjects are introduced, and the decoration is no longer confined to architecturally designed squares, but runs in a free band or series of bands around the vase; these bands are in the form of rows of conventionally painted animals, with every available space between the animals filled in with rosettes; in the tombs from which these vases come are found numbers of little rosettes of precisely this form, under circumstances which make it certain that they were imported from the East, and were used for sewing upon garments; and upon the Assyrian sculptures of the 9th and 8th centuries B.C., we see figures wearing robes which are decorated with the same rosettes, and the same conventional animals.

* See *Hellenic Journal*, vol. iii, p. 27.

Alkisthenes, of Sybaris, is said to have had a robe made for him which was decorated with three bands of pattern; in the upper band were the sacred animals of the Susians, in the lower those of the Persians, and in the centre the gods of Greece; a description which at once calls to mind the ornamentation of the vases in question, and points to their Persian origin.

I have dwelt somewhat upon vases, because they show us more than anything else what is the real difference between Eastern and Western art; a difference which underlies the principle of all applied art, and which must be understood if we wish to estimate Persian textiles at their real value. In the Eastern world art is essentially decorative, and can hardly be said to exist except in a subjective form, in dependence upon that which calls it into being; whereas we of the West are ever trying to approach more nearly to the independent representation of nature itself. On the one hand the tendency is away from the real to the decorative, and therefore the conventional; on the other, the tendency is always more and more in the direction of realism. Each end is legitimate in itself; the danger obviously lies in the possible confusion between those undertakings which are really separate and well defined for both. I cannot do better than to quote a passage which appears in this month's *Scribner's Magazine*, and which exactly represents my meaning:—"In strictness, to decorate is to add beauty to something by adding to it ornament, or perhaps colour, and implies something to be decorated. It is easy, in the desire to do something called decorative, to think of the charm of what we are doing, without regard to the thing to which we are doing it. A picture exists for itself, and is supreme; a decoration, existing for the sake of the thing to which it is applied, is subordinate. How far in any kind of work the pictorial element may prevail, and how far the decorative, is to be determined by that sense of harmony and fitness which is the artistic conscience, and, like the moral conscience, needs the enlightenment of discipline." The writer goes on to point out that this lesson is specially inculcated on us by the example of Oriental races; for if a Persian artist has to design a stuff amenable to the scissors, he may allow himself the full licence of "all-over" ornament; but if he has in hand a plate or a tile with its firmly circumscribed outline, his systems of ornamentation are at once altered and adapted to the special circumstances of the case.

There is a passage in the Koran which says:—"O, ye faithful, of a truth wine, gaming, *images*, and the casting of lots, are things to be held in abhorrence;" and among the utterances attributed by tradition to Mahomet, is the following:—"Woe unto him who paints the likeness of a living thing; on the Day of Judgment those whom he has depicted will rise up out of the grave, and ask him for their souls. Then, verily—unable to make the work of his hands live—will he be consumed in everlasting flames."* In Persia, where the Mahommedans belong to the Shiite sect, this sentiment is, fortunately for us, not understood quite literally. In any case, it is the expression, rather than the cause, of this characteristic of Persian art, especially as regards textile fabrics. In decoration, which these artists thoroughly understand, the first consideration is, as I have said, that of the purpose for which the object decorated is intended. Nothing can be more inartistic than to represent an object in nature which, however beautiful in itself, is rendered ridiculous by its associations when in use. Mr. Redgrave, in his "Manual of Design," points out how offensive it is to good taste and common sense "to tread upon a carpet of water lilies swimming in blue pools, or on fruits and flowers, heaped up, and casting shadows, probably towards the light. Woollen lions and tigers, as large as life, basking before the fire, in a wreath of roses, are alarming rather than agreeable, and are in the nature of a practical joke in art."† It is equally absurd to represent a single large animal upon a fabric which is intended to hang in folds, where its tail may, as likely as not, appear as springing from the back of its head; or which is meant to lie upon the floor, where one would only feel happy in sitting on one side of it. Obviously, figure design should be reserved for that which has a regular definite up and down, and which shows properly only in one aspect; or if in other cases figure design is essential, it should be conventionalised—that is, the figure, or group of figures, should be of such a size that it can be repeated over and over again on the same object, so that if one instance of the pattern is hidden in a fold, the eye need merely turn to the repetition beside it; if one pattern is upside down in a given aspect, the adjoining pattern explains

* See Woltmann and Woermann's "History of Painting" (English edition), p. 492.

† Lady M. Alford, "Needlework as Art," p. 95.

it, without causing the mental exertion of standing upon one's head in imagination. Or again, as a third alternative, the difficulty is removed if we alter the figure which is represented in such a way as to do no more than suggest the object in nature from which it is borrowed.

This, then, is the origin and the *raison d'être* of the art of conventionality; an art which has been the subject of a good deal of unmerited execration. Like many other things of which the use in season and moderation is beneficial, it has its dangers and drawbacks in abuse. Of these the Greeks had an example before their eyes in the art of Egypt, where an originally healthy growth was choked by the prescribed canons of conventionality, which it had suffered to grow up too closely around it. They learnt—what the early Persians knew, and what these textiles show us—that it is a good servant, but a bad master; and the history of their early pottery shows us how the Greek genius, which threatened at one time to yield to its dangerous fascination, gradually mastered and controlled it, until it had, by means of it, evolved the beautiful series of patterns which we know so well. The danger of conventionality in decoration is twofold; on the one hand, there is the tendency of overloading a design, so that the eye tires itself out in the attempt to work order and meaning, as it were, out of the mazes of a tangled skein. On the other, the tendency to become merely mechanical, when the decoration sinks to the level of a geometric dulness, and the mind longs for something which is not absolutely *banale*, and accurate, and regular. These two faults are conspicuous in Arab art, and, indeed, mark principally the distinction between it and the art of Persia. In Arab art we can trace the ornaments borrowed from flowers and plants, as they become more and more regular, until they are nothing more than mere linear patterns. Bands of inscription become the leading decorative motive, and the whole system of form is determined by the narrowest limits of textile art.

What is needed is, first, a knowledge of drawing, that a man should know thoroughly the beast, or the bird, or the flower, which he is intending to use in his design, and secondly, that he should know how to apply them. It is precisely this which the old Persians thoroughly understood, and which our modern designers are now beginning to understand. There lies in common sense and judgment something which tells them, in making a wall-paper, exactly how many flowers they should put into a given space, in order that it may neither be on the one hand mean and ineffective, and on the other, that the person who lives with the paper before his eyes may not go mad in trying to count the patterns in all sorts of directions. It is "the architect's great trust, harmony of proportion."

Another great evil which Persian textiles teach us to avoid is the necessity of formal symmetry; and here I may quote, what you may perhaps know well, the words of John Ruskin. In his lectures on art called "The Two Paths," he says:—"If you learn to draw a leaf well, you are taught in some of our schools to turn it the other way—opposite to itself, and the two leaves set opposite ways are called 'a design;' and thus it is supposed possible to produce ornamentation, though you have no more brains than a looking-glass or a kaleidoscope has. But if once you learn to draw the human figure, you will find that knocking two men's heads together does not necessarily constitute a good design—nay, that it makes a very bad design, or no design at all; and you will see at once that to arrange a group of two or more figures, you must, though perhaps it may be desirable to balance or oppose them, at the same time vary their attitudes, and make one not the reverse of the other but the companion of the other." The Persians of old knew this principle, and whenever their design shows the least danger of becoming unduly symmetrical, they make quite obvious efforts to evade the tendency. Indeed, some might think that their efforts in this direction are occasionally carried too far, for their houses are seldom truly square or their carpets the same width at both ends; but whether this is due to the carelessness of the artist, or to his artistic instinct, I could never tell.

There is yet another quality which has given Persian textiles their pre-eminence, and which I think you will recognise in the examples before you, and that is the quality of their colours, and the art with which they are used. Mr. Floyer, in his "Unexplored Baluchistan," speaks of the brilliancy and lasting qualities of the dyes which the Persians, by slow and tedious processes, extract from plants—from the "runaschk" (madder) a fine red; from the "zarili" (the golden), which is a yellow flower from Khorassan, and also from the leaves of the vine, a bright yellow; while a dark yellow is produced from the skin of the pomegranate by boiling it in alum. They

import indigo from Shastra or India by the Karun river. These dyes are perfectly fast, and leave no trace on a wetted rubber, whereas the European dyes which they are now beginning to employ come off freely.* It is perfectly horrible to think that these pure unadulterated vegetable dyes, which conservative tradition, as well as, I think, a conscientious motive, has kept in use for time immemorial in Persia, should be now replaced by the miserable aniline productions which a mercantile interest imposes. It is quite extraordinary to notice how people who are accustomed to discern what is ugly and hideous in their own art products can entirely lose this sensitiveness when confronted with the products of a foreign nation. We have seen it ourselves in some phases of our own Japanese craze, and it is so now, unfortunately, in Persia. I was much struck with this one morning, in Kashan, the very place where I bought most of the beautiful old fabrics before you. I stood there a long time, in the cool shadow of the bazaar, beside the den of a seller of cloth, while, one after another, the dark-veiled Persian women came up, to paw the samples over, and harry the unfortunate salesman, for all the world like any English lady in a West-end shop. The Persian stuffs were cheap and good, and of colour suited to their purpose; these they never so much as looked at, choosing always the hideous monstrosities which Manchester provides "for foreign consumption." The lands which were the cradle of art, and which for thousands of years have produced beautiful things as a natural growth, are now at last penetrated by our corrupting bad taste. In future we may expect from them only gaudiness and vulgarity, the bastard outcome of our mercantile spirit. For they will make no more. The art of the finest silk weaving has long since disappeared; the art of chintz printing, of which two large specimens and several smaller ones on the back of the silks are here exhibited, is fast dying out, and with our present improving prospects of trade with Persia, they will probably very soon exist only in tradition; unless, indeed, a Shah should arise, gifted with wisdom such as one of our Indian Princes has shown. The Maharajah of Cashmir has devised a most efficacious plan for the suppression of magenta dyes within his dominions. First, a duty of 45 per cent. is levied on their entering the country, and then, when they are a certain distance within the frontier, they are confiscated and destroyed.

* Lady M. Alford, "Needlework as Art," p. 188.

I am afraid that the present Shah is not likely to be prevailed upon to this extent, and so, for the future, we shall have to be content with studying the ancient specimens.

For these reasons, and also because the Persian process of bargaining is somewhat lengthy, and gives the student great opportunities of practising the language, and exploring the internal workings of the Oriental mind, I was glad to have an opportunity at Kashan of making the purchases before you. I may say that each single piece represents a good hour of steady, ding-dong, up and down argument, for I sat there the best part of two entire days in the room of the English telegraph official, while they squatted round by the dozen in their long lambskin hats and cloaks, looking like a row of magicians playing at hunt-the-slipper. My Persian servant had sought them out in the highways and byways, and many and various were the things they brought. Where they had got them from goodness only knows; most were probably the accumulation of ages, stored up as relics in families of bygone splendour. The majority of the silks, it will be noticed, are in the form of a square, of which the edging and corners are usually of a different fabric or pattern. This is the form in which old silks are generally now met with in Persia; it is called "Boghcheh," and is usually intended for covering ceremonial presents, dresses of honour, and other similar purposes in a rich Persian house. Sometimes, as in No. 7 on the wall, the square is woven or embroidered originally with a view to its adaptation to this form; but the majority of instances, if you examine them closely, will be found to be made up of a great number of pieces sewn together. These pieces are often of the most varied shapes and sizes, so that one wonders that the artist should have taken so much trouble in collecting and preserving so many small shreds of pattern. The reason is that these patched-up fabrics are, as a rule, composed of the coats which Persian ladies formerly wore in the harem, but which, like so much else which in the old time was beautiful, have gone down before the inexorable laws imposed by fashion and European importations. These fineries, many of them the inherited treasures of centuries ago, when no doubt they were jealously preserved in the wardrobes of rich ladies, are fast going the way of all flesh; the first stage was when the grand ladies discarded them in favour of their slaves; and at the beginning of this century it used to be a common sight to see at a great

function the upper ten dressed in gaudy European fabrics of bad taste, while the slaves of these same people would appear in the finest fabrics which perhaps looms have ever produced. Now, even for slaves, they have gone out of use, and are sold to the native merchants to be cut up for the purpose which I have said. It is therefore somewhat rare to meet, as I did, with a coat which is still complete; it is the one before you, which when worn so as to show on the chest and sleeves the simple shirt of white gauze, must have had a very pretty effect. The other coat, which has lost its lining, is Kurdish; it is composed of a dark maroon fabric which is much in use at the present day, edged with a very pretty border in coloured silks and gold thread, in form suggesting exactly the Greek *anthemion* pattern, from which it may well be a distant descendant.

The typical form of the Boghcheh is that of No. 19, where the edging, corners, and centre are all of different design; and it speaks well for the excellence of the dyes used, that in these Boghchehs colours which we should consider most inharmonious combine with an effect which is pleasing to the eye. There is much to be learnt in them, both by the student of colour and design. The Persian artist is thoroughly at home in his material; just as India has been from time immemorial the country where the inhabitants have clothed themselves in cotton, so through all the centuries of our era the mention of silk fabric has been nearly associated with Persia. It is certain, at any rate, that its production must date from before Mahommedan times; because the use of it, as being an animal excrement, is specially forbidden by the Koran to Mahommedans, unless mixed, either in the weaving or making up, with cotton. Next to the marvellous variety and beauty of the colouring, the point that strikes one most is the skill with which the weaver endeavours to avoid anything in the way of a flat, monotonous surface; for this he has numerous devices at his control. Sometimes the fabric is shot, the woof and warp being of different colours; in the majority of cases he employs gold thread in such a way that it is almost indistinguishable from the silk, but adds a wonderful variety and brilliancy to the whole. The use of gold thread in weaving may be traced to the earliest times, and always seems to have been the particular characteristic of Oriental manners. Yates, in his "Textrinum Antiquorum," traces its history through a great number of references in ancient writers back to the time of Aaron, for whose ephod, girdle, and breastplate it was used; this, however, was not gold thread properly so-called, but thin strips of beaten gold, employed, as he adds, on a system which is adopted for the ornamental silks of the Chinese to the present day. It seems probable that the first use of gold drawn wire was brought in by the Persians. Quintus Curtius describes the outer garment worn by Darius when he advanced to oppose Alexander as a mantle shot with gold, on which were groups of golden hawks attacking each other with their beaks; it is curious, in reading this description, to notice in some of our textiles the little groups of pairs of birds confronted. I have seen similar patterns in some of the fabrics of Byzantine times, and there is no reason why our birds should not trace their pedigree back to the hawks of Darius.

The use of gold thread, however, does not show itself, it appears, pleasing to everybody in the same way. The author of a clerical treatise composed in the 4th century or 5th century, "Concerning the Discipline and Good of Modesty," remarks that, "To incase gold in cloth is, as it were, to adopt an expensive method of spoiling it. Why do they," he says, "between the delicate threads of the warp interpose stiff metals?" He can hardly, I think, have seen many such fabrics, or else his austere defence of modesty got the better of his taste.

To the present day in Persia gold thread is a material much in favour; the natives of the "land of the lion and sun" have the great advantage of a climate where for ten months in the year there is absolutely no damp to tarnish the metal. The modern usage of it, however, is less that of weaving than of embroidery, such, for instance, as No. 7, with the red centre and blue edging, where the patterns are of gold, silver, and coloured threads. It is interesting to observe, in comparing the edging of No. 12, which is of a more recent date, with the older work in the same materials, that the modern fabric, resembling coarse tinsel, only serves to exaggerate the glaring colours laid upon it; whereas in the older specimens the colouring blends with, and at the same time is lightened by the gold background. No. 8 is remarkable as an instance of exquisite delicacy of weaving upon the rarer silver warp; here the woof is of a pinkish silk, which gives, in combination with the silver, a wonderful shot effect. So subtle is the weavers'

art, that the flowers, although conventionalised as much as is necessary for decorative purposes, and coloured with perfect good taste, would seem to be painted in water colours; one is almost tempted to think of the pre-Raphaelite flowers on the gilded fields of some of the Holy Family or saints' pictures of the early Florentine schools. I cannot find much reference in antiquity or elsewhere to the existence of woven silk fabrics; one remembers the "royal apparel" worn by Herod Agrippa, King of Judæa, when he received in state the ambassadors of Tyre. Josephus describes his dress as a tunic made wholly out of silver, so that it was a marvel of weaving to behold; but this was apparently made of the silver thread pure and simple. Is it possible that this may have been the "white samite, mystic, wonderful," of the Middle Ages, of which nothing is known except that it was a six-thread silk-stuff, inwoven with threads of precious metal?

I would specially call your attention to the series Nos. 18-22, where the pattern of the central square is raised on a sort of velvet pile from the "couch" of cloth of gold. I do not know of any other specimens of this work which have yet been brought from the East; they suggest more than anything else some of the early ecclesiastical fabrics which came from Italy, Spain, and Portugal, and of which there are specimens in the South Kensington Museum. Now these three countries, with Sicily, were most instrumental in the introduction into Europe of the silk fabrics of the East. In 1148, Roger King of Sicily settled near Palermo a number of Greek and Oriental silk-weavers, who might have been seen, we are told, "employed in weaving velvet stoles interwoven with gold, like the Eretrians of old among the Persians." This is probably the first mention of the appearance of velvet in Europe, but it was known already as an Oriental fabric; it figured among the gifts presented to Charlemagne by Haroun Al Raschid; and all the evidence goes certainly to prove that it was imported originally from the East. Considering, therefore, the Oriental character of both the gold and the velvet, I think we are justified in claiming for these pieces the origin of the similar fabrics of Europe. So far as I could judge in a comparison with those at South Kensington, the Persian specimens are undoubtedly finer both in colouring and texture. In any case, they seemed to me some of the most beautiful things of the kind that I had ever seen. The strong contrast between the radiant, rippling light of the couch (which is either of cloth of gold or silk) on the one hand, and the solemn rich tones of the velvet on the other, is wonderfully handled here. Perhaps the most remarkable are the two squares of delicate apple-green and brown velvet, which stand out from a delicate salmon-coloured silk. Each of the little diamond-shaped patches of velvet has worked in it a bunch of roses, of which the eyes of the flowers are picked out so as to show the background through. The whole is so contrived that with every movement in the light it suggests all the most exquisite varieties of tints, which lie between the deepest green and the most brilliant yellow. Looked at at a distance, each bunch of roses stands within a diamond-shaped space, around which the background forms a kind of chain pattern. This scheme of design is a favourite one amongst the best carpets of the 17th century, and I think these two stuffs can hardly be later than that date. In their case the maker up of the Boghcheh has shown great taste in the choice of a border—where the same shades of green and gold predominate, and a definite dark frame is secured, which throws up, without interfering with, the main design.

In the choice of borders we must not criticise these Boghchehs too closely, remembering that the centre piece as a rule was never intended to be used in this way, and that the borders, such as they are, have been selected usually by the merchant who sells them, and not by the original artist himself. For a study of borders we must go to the carpets, where we shall find that the borders are so arranged as to set off and define, while they harmonise with, the main field of the pattern.

The principal seat of the silk manufacture has always been in the Northern Provinces of Persia, where there is a strong element of Turkish or Turanian in the population; and one would expect to find more traces of this than seem to exist. No. 26, a door-hanging of salmon shot silk embroidered with gold thread and silk seems to be an example of this influence, both in colour and design. Sir G. Birdwood has pointed out that the use of the geometric system of ornamentation prevails among the lower Turanian races, and that the floral system is usual among the higher Aryan. No. 37 is probably an example of Turanian influence; a piece of embroidery in geometric patterns which has the same finish on both sides, and of which the colouring seems to resemble more that which we know in the old Bulgarian work.

The influence of Chinese art upon Persia is well defined in pottery, and occasionally in carpets, from a very early period. No. 32, though apparently of Persian work, seems, with its groups of water-birds, to suggest a motive borrowed from Chinese art.

No. 44 is a prayer-carpet, intended for use in the house; it is worked in white silks, upon a white cotton ground, and is an excellent example of the principles which Semper* has laid down as governing this kind of embroidery in the best art. The special properties of flax are its freshness, smoothness, and endurance; in placing work upon linen, we should, therefore, be careful that it does not interfere with these qualities and merits. If we would preserve its inherent freshness, we should avoid all projections in our work, such as would catch the dust or throw a shadow. And if we would keep its smoothness, we must apply a flat refined thread, for which a shining, flat, satin stitch, would be most appropriate. A cool, smooth surface needs a cool principle of colouring. The white ground forbids any attempt at violent contrast, and so the work has been executed in flat, long stitches, of a material which does not jar, and at the same time enriches the humbler material on which it is placed. This prayer-carpet has its decoration arranged with a practical view of the purpose for which it is intended. In a carpeted room the difficulty of obeying literally the commandment of the Koran, to bow the head to the ground in prayer, is got over by placing on the carpet a small disc of clay, if possible, of holy earth from Kerbela, and touching it with the forehead. This carpet is decorated with a panel in form of the sacred niche, the point of which is laid, when the carpet is in use, towards Meccah. In the angle of this niche is a space marked out for the piece of clay; below this are spaces embroidered, representing the palms of the hands, and lower still, the comb, which the devout Mussulman uses at his evening prayer. At the foot are represented the water-pot and water-pipe, without which no Persian is properly equipped. No. 43 is a similar carpet, of less rich decoration, where the design is merely indicated by quilting in silk.

Nos. 33 and 34 are a pair of ladies' trousers, such as used to be worn long ago; at present, the indoor dress of a Persian lady dispenses entirely with leg-coverings, though I believe that in the *beau monde* the fashion is coming in of long trousers of black cloth, with a gold stripe. In the old days, from which our specimens date, a pair of "nakshes" were supposed to occupy a girl from childhood until her marriage in the making; and when one comes to examine the thickness and elaboration of the needlework with which the coarse calico groundwork is completely hidden, this may readily be conceived. I was lucky in getting, besides, a pair of nakshes, Nos. 35 and 36, which were never finished, and which show the method of working them. Possibly they may have been the work of some girl who died before she arrived at the marriageable age.

Nos. 38—40 are three specimens which we may consider as illustrative of the two main branches of Eastern lace-work. They have probably served for decorating the ends of shawls or veils, a purpose for which lace-work may very likely have originally taken its origin, as suggesting, in some measure, the frayed ends of textile fabrics.

The pattern upon the two white specimens is very much like that of the usual Oriental lattice-work in wood; that is, it consists of a number of small circles, each of which has four radiating arms. It would be interesting to know whether this pattern was earlier in wood than in textiles. In the 12th century we are told that a lace-work was practised which was called *opus filatorium*, and of which the principle was as follows. Half the threads of a piece of linen were drawn out, and the remainder were worked into a net by knotting them into groups, and then by dividing and knotting them again. This certainly seems to suggest a natural textile origin for the pattern before us; it may be only a coincidence that this kind of lace-work is used for the *yashmak*, which in the outdoor dress hides the face of the Persian lady; while, in wood, it would serve a similar purpose as the window of the ladies' apartment in the harem.

The other specimen is made with silks on a coarse net, with a slight intermixture of gold thread to lighten the sombre colouring. Here also the design is suggestive of the purpose for which the lace is intended, viz., that of hiding something. It is in the form of an upright floral pattern, such as would be used in metal for a screen, and such as we see on the bottom of the prayer carpet No. 44. Perhaps the idea of this screen is also intended to be suggested in the prayer carpet, the motive in both being that of keeping off all which has no right to be there.

I am sorry that I have not been able to

* "Der Stil. i., p. 132.

bring here to-night more specimens of carpets, without which no notice of Persian textiles can be really complete. I have, however, two pieces, which will serve to illustrate the difference between the floral and geometric style to which I have already alluded. The first of these, unfortunately a mere fragment, has a special interest, inasmuch as it can be dated with certainty as far back as the first half of the 16th century. I got it in a place which was built by Shah Abbas in about 1586, and local tradition says that it was already old when he brought it there. Judging from the design, which recalls to me the freedom and simplicity almost of the Greek acanthus pattern, I believe this is one of the earliest specimens in existence. For a study of old Persian carpets, nothing could be better than a reference to the splendid illustrations of Mr. Vincent Robinson's "Eastern Carpets" (with a preface by Sir G. Birdwood); from this we may learn the origin of many motives now misunderstood, and the connection, in some cases, between the patterns of embroideries and of carpets. A journey through the south of Persia in the spring shows one at once whence the idea of a floral pattern in carpets comes; nothing can exceed the beauty and brilliancy of the colouring when, after the rains and before the great heat, one's horse's feet tread upon a veritable carpet of nature.

The other specimen is a small *portière*, constructed to cover the entrance to a Turcoman tent. Here the pure geometric ornament is at its best, and is saved from being monotonons by the quiet rich tones of colour and the velvety pile. This is another art which I am sorry to say is in danger of disappearing. I was informed by a Russian officer at Teheran, who had been through the Turcoman campaign, that the Turcomans are entirely giving up the manufacture of carpets; the reason is that Russian administration is discouraging a nomad existence, and is collecting the wanderring tribes in cities, where tent hangings are no longer a necessity of existence.

Enough has been said, I think, on the subject of these textile industries, to show the extent of our indebtedness to Persia; of that which Persia owes to us in return it were better perhaps not to say too much. Eastern art is especially in favour amongst us at the present; and with the prospect of improved trade relations, which the latest news from Persia brings, it will probably come still more amongst us. Let us hope that our own export manufactures may have time to improve themselves before we complete the task which is begun, of utterly degrading and corrupting an art which has been pre-eminent as far back as the records of the human race can go.

DISCUSSION.

The CHAIRMAN said the Society was much indebted to Mr. Cecil Smith for his very interesting and valuable paper, and he hoped it would lead to some equally interesting discussion.

Mr. PURDON CLARKE asked if Mr. Smith had noticed in any of the factories in Kashan where silk was woven, any cards or counts used for securing repetition of the patterns. He knew they were apt to hide things of this kind, but he found there were some large looms worked by power, some, he was informed, by horse-power; in those which he saw there were five or six men driving a large wheel which worked several looms, or spinning machines. In answer to questions, however, whether there was any system of cards in use, he could only get a shake of the head, which often meant more yes than no; but still he could get no definite information as to any means of registering patterns. He traced it, however, in India and other places, and it would be interesting to know whether in Persia there was any system in vogue which rendered it unnecessary, when the pattern was once made, for the artist to continue superintending it.

Mr. SMITH said he did not hear anything of the kind, but his study was rather from the artistic than the technical point of view. He was not in any town very long, and had no opportunity of studying the manufactures.

Mr. CLARKE suggested that possibly some information on this subject might be obtained through the members of the telegraph service, who were resident in Kashan. He knew that in several parts of India they had a system of counts, or tallies, "talm" they were called, but there was a disposition to keep them secret. They were written in a secret character and in a secret language, which he believed Dr. Leitner had discovered to have some connection with the gipsy language. He thought this Indian system of weaving counts would be found to have affinities with a similar system which existed in Europe in the middle ages.

Mr. SMITH said he was in correspondence with one or two people in Persia, and he would see if any information on this subject could be obtained.

Mr. ALAN COLE said he had listened with great interest to this paper, and he should like to know if Mr. Smith had examined the old silks lately brought

from Ekhmim, and if so, whether he could trace them in any way as being of Persian origin.

Mr. SMITH said he had only been able to see a certain number which Mr. Greville Chester brought over, besides those of the South Kensington collection. In those which he saw there was much which one could trace as Persian. On some there was an evident imitation of Greek myths, like those from the tombs at Kertch, where there was found, in one case, an obvious copy of a Greek myth from a vase.

Mr. STANNUS wished to express his thanks to Mr. Cecil Smith for his very interesting paper. In the beginning of it there was a short discussion on conventional treatment, which was one of his own special subjects, but he hardly thought it would be proper to enter on a discussion of that when the real subject was Persian textile art, and of that he knew nothing. Mr. Smith's remarks about the Byzantine lions were exceedingly interesting. He had noticed them in the splendid collection at South Kensington, and had seen them figured in books.

The CHAIRMAN said there could not be the slightest doubt of the derivation of Persian art from Mesopotamia, and ultimately from Egypt. Between the 9th and 7th centuries B.C., an Egypto-Mesopotamian type of art had been developed all over Anterior Asia. In the West it was gradually transformed by the rationalising genius of the Greeks into classical art; but in the East its original Egypto-Mesopotamian character has everywhere remained stereotyped from the time of the Sargonids of Nineveh (B.C. 722-626.) Of course, allowance has to be made for local modifications, and for the modifying influences of the reaction of Europe on Asia, directly through the Greek and Roman conquests, and indirectly through the Arab conquests, which, in a sense, perpetuated the reaction of Europe on Asia, "Saracenic Art," so called, being, after all, a Greek adaptation of the old Egypto-Mesopotamian art of the Sargonid period to the uses of Mahomedans, who, as for the most part, inflexible monotheists, have the strongest objections to the decorative use of animal forms. But the Persians are of the Shiah sect of Mahomedans, or, in other words, are Aryan Mahomedans, and in their art as in their religion, and literature, and whole social economy, their Aryan love of nature asserts itself over the arrogant prejudices of their Semitic religion; and thus the Persian variety of Saracenic art is distinguished, not only by its partiality for secondary rather than primary colours, but even more by its marked preference of animal and vegetable decorative forms to geometrical. Persian art has in this way preserved many indubitable proofs of its origin in Assyrian and Babylonian art. The "spear head pattern" so often seen on the borders of Persian carpets may be traced back at last to the running pomegranate pattern of the fresco paintings of the palace of Assur-nazir-pal (B.C. 885-60) at Nimrud (Calah), and of the palaces of Sennacherib (B.C. 705-681), and Assur-bani-pal (B.C. 668-26) at Koyunjik (Nineveh). The Assyrian "Tree of Life," which generally takes the form of a palm tree, encircled with a climbing vine, is occasionally represented as a pomegranate tree, the symbol of Rimmon, the personified summer sun, which, after ripening the luscious fruit of the pomegranate, sinks for the winter into the nether world, below the equator, and was mourned in antiquity until the return of spring as a dead deity. You will remember that the prophet Zechariah (ch. xii. 11) describes the grief of Jerusalem in captivity, "as the mourning of Hadad-Rimmon in the valley of Megiddon." The fruit of the pomegranate as a symbol of Vul or Rimmon, appears everywhere in Assyrian art. We know also the part it played in the decoration of the temple of Solomon at Jerusalem; and in the ornamentation of the ephod of the high priest of the Hebrews; and it is still used in its old Assyrian conventionalised forms, without any appreciable modification, in the carpets, and silks, and embroideries of Central Asia, and throughout Persia and India. Even in the West we find traces of the once universal use in art of this floral symbol of Rimmon. The counter weight of the Saracenic balance was always moulded like the fruit of the pomegranate,* called *rumman* by the Arabs; and this is why the steelyard is to this day called *romano* by the Spaniards and Portuguese, and *romaine* by the French. Again, the English word "banister," corrupted from "baluster," is the Italian *balaustro*, Latin *balaustium*, and Greek *balaustion*, the dazzling vermilion flower of the pomegranate; and this etymology prompts the surmise that the balustrade, or open parapet used in architecture as a decorative screen or rail may have had its suggestive source, in the pomegranate border pattern of Assyria. There is an indication of some sort of connection between them even in the later Italian balustrade, composed of the little, round, uniform pillars we call "balusters" or "ballisters," † and the demonstration of its existence probably lies latent in the older Gothic balustrade of interlaced curves, often supporting "ball-flowers," or other rythmically inserted variegations of the "knop and flower" pattern. I have already, in my "Handbook to the Indian Court," at the Paris Exhibition of 1878, traced in detail the infinite permutations of the "knop and flower" pattern in Eastern art back to its Assyrian prototype on the carved thresholds of the palaces of Sargon [Khorsabad] and Sennacherib. These thresholds were obviously copied from carpets; and the fresco paintings above the sculptured dados of the Assyrian palaces were undoubtedly also

* The fruit of the mango takes its place in India.

† The spelling "ballister" has arisen from a confusion with the Latin *bollista*, through the Italian *balistrariæ*, meaning the cruciform loopholes in the walls of mediæval castles, through which the bolts or quarrels of the crossbow were shot.—G. B.

copied from hangings and other textile fabrics. Esarhaddon, describing the building of his palace on the Nebbi Yunus Mound at Nineveh, says, "I embellished the ceilings of the apartments with veneers of ivory and alabaster, and the walls I covered with plates of pure silver and bright copper, and with embroidered hangings." Now the word used in all the Assyrian inscriptions for the verb "to embroider" is *rakam*, which is not only retained in Hebrew and Arabic, but reappears unchanged in the Spanish and Portugese *ricamare* and the French *recamer*, "to embroider." The past participle of the Arabic *rakam* is *markum*, and *markum* means a carpet throughout the north of Africa. In old Spanish inventories also we find the word *morgomes* used for carpets, particularly striped carpets. This etymology of itself carries the art of embroidery, and of decorative weaving generally, back to their archaic sources in the valley of the Tigris and Euphrates. The Chairman then proposed a vote of thanks to Mr. Cecil Smith, which was carried unanimously.

CANAL CONFERENCE.

Friday, May 11th, 1888. [Continuation of report.] Col. A. C. HAMILTON, R.E., Member of the Council in the chair.

SOME REMARKS ON THE CANALS AND INLAND NAVIGATION OF FRANCE, BELGIUM, AND HOLLAND.

By WILLIAM JOHN CHARLES MOENS, F.S.A.

An ever increasing foreign competition is pressing hard on the agriculture and manufacturing interests of this country. Handicapped by the products of silver and paper currency countries on the one hand, and by the free import of the surplus manufactures of Germany, France, and Belgium on the other, our farmers and manufacturers are at their wits' end. Their former natural advantages have been lost one after another, and the greater carrying power developed by vessels through compound engines and triple expansion of steam has reduced the freight of wheat from 10s., as estimated by Mr. Cobden, to sixpence a quarter, from America or India. As with corn, so with other goods. This cheap conveyance ends, however, with the port of arrival, railways charging for a very few miles the same amount as paid for conveyance from America. The determined and successful fight for cheap water conveyance to Manchester, the centre of our manufacturing districts, is drawing public attention to inland navigation. France, Belgium, Holland, and Germany owe much of the great increase of their commerce to their admirable systems of canals and canalised rivers, which not only enables heavy traffic to be cheaply carried to the very doors of factories and to markets, but induces a wholesome competition on the part of the railways, and thus goods rates are maintained at a low level.

With but very few exceptions, our system of canals, with barges of twenty to seventy tons, has been on so small a scale as to be practically valueless. Locks of a size to pass one barge at a time cause delay when steam towage is used. A new departure is required, and we have to look abroad to see what can be done in the way of carrying heavy goods at a cheap rate on canals and rivers. As the much increased carrying power, and the development of the modern engines, have reduced so much the freight of foreign and colonial produce, so may we reasonably look for a similar reduction in the carriage of goods on canals by the use of larger barges and suitable steam-power.

Mr. Vernon Harcourt, in his able paper on "Canal Engineering," states that the tonnage on the 4,709 miles of navigable rivers, and 2,889 miles of canals in France, amounts to about 9,300,000 tons; and Mr. Jebb notes that, with depressed trade, the 162 miles of the Birmingham Canal alone had a traffic last year of 7,000,000 tons. This proves that there must be a great unsatisfied demand for canal navigation, which would provide ample traffic if suitable canals were made, and rivers canalised, to carry goods at a low rate.

It may therefore be useful to cast an eye on the foreign system of canals, which, from a very early date, were constructed on a scale undreamed of in this country.

In France the improvement of rivers and construction of canals has been encouraged and fostered by the State since the commencement of the 15th century, and indeed, some of the canals are of a much older date, having been made in the time of the Romans.

The comparatively modern use of railways has not diverted the attention of our neighbours, but greater encouragement has actually been given for the use of the navigable ways, in order that the general welfare of commerce might benefit by competition, the railway rates being thus kept down to a moderate price. Since 1879 vast sums have been expended in deepening and ameliorating the more important routes, all of which, with but trifling exceptions, are State property. The inland

craft, which are chiefly barges (called *péniches*) of about 270 tons, are all licensed and under police discipline; they belong, as a rule, to those who work them, though there are companies which own a number; those working these craft are very superior as a class to our bargees, and their wives and children live on board with them. Various insurance companies grant policies on these inland vessels and their freights at low rates.

Paris is the natural centre of the French canals; the barges find their way there from the ports of Dunkirk, Gravelines, Calais, and Havre, large quantities of coal, iron, and wheat being carried, and in the fall of the year the cargoes of numerous timber vessels are made into rafts and floated to their destination, but of late years the increasing quantities of planks and deals sawn in the North, are loaded into the barges. The important coal and iron districts of Belgium, at Mons and Charleroi, provide much freight for Paris, which goes *viâ* Condé from the former, and Landrecies from the latter, the two routes uniting at La Fere, whence the Seine, at Conflans, is reached by descending the River l'Oise. The River Rhine is communicated with at Saarbruck and Strasburg; Switzerland at Bâle, and the important ports of Marseilles and Cette by the Yonne, the Burgundy Canal, and the rivers Saône and Rhone. The western ports of Nantes, Brest, and Bordeaux have also canal communication with Paris.

Vast sums have been expended on these waterways by the State, amounting in the years from 1814 to 1870—1st, for extraordinary works, 746,209,000 francs; 2nd, for ordinary works, 427,006,000 francs; total 1,173,215,000 francs. Besides this sum, there are annuities (which expired in 1882) of 1,346,327 francs; others, payable to 1890, of 3,116,096 francs. Since 1870, notably from 1879, a further large liability has been incurred. It must be remembered that the greater part of these works were commenced before the invention of railways, and were then absolutely necessary for commerce, but since railways were in full working, and particularly of late years, the inland navigation has been immensely improved, for the very purpose of facilitating the conveyance of goods and heavy mineral traffic, by which commerce and the possibility of successful competition with other nations have been greatly benefited.

The large *péniches* of 270 tons, which are about 116 feet long, 16 feet beam, bluff at bow and stern, and almost flat bottomed, draw 1·80 metres when loaded; they are worked most skilfully by two men and the wife of the captain. The value of these craft, with their equipments, is from 10,000 to 15,000 francs, and they are always insured against damage or loss. In all rivers and places with the slightest risk, the use of pilots is compulsory.

The rules of the Administration for the guidance of barges are numerous and very stringent. The vessels are placed in five classes, according to which they are passed through locks, bridges, &c. Vessels propelled by steam take precedence of all others, but on many routes special permission for this class is necessary. Those authorised as *bateaux accélérés* have extra rules and privileges, and are allowed to travel by night. On the Seine, Saône, Rhone, and some other rivers, and certain portions of some canals, is found a very cheap and powerful method of towage by means of a submerged chain or wire rope, which the tug, or *remorqueur*, with steam power, raises from the bottom as it progresses, it being nipped between revolving pulleys, and when extra power is required, having three turns round an iron drum. The traffic on the St. Quentin Canal, through the Riqueval tunnel, 4½ miles long, is thus worked, and I have seen twenty-nine barges, each laden with 270 tons of coals, towed at a rate of about two miles an hour, by means of a small tug with engines of 20-horse power. It will be noted that the late experiment of towing barges of an aggregate weight of 100 tons, including their freights, by a locomotive engine, on rails laid on the tow-path, compares very unfavourably with the above system.

The locks on the more important routes all accommodate these 270-ton vessels, but in places with large traffic they are found 130 yards long, by 13 yards wide, to allow several vessels to pass through together. The hours of work, as a rule, are from an hour before sunrise to an hour after sunset.

In 1870, the freight by water for coals, with 75 c. more for coke, per ton, was as follows:—Mons to Paris, 235 miles, 7 frs.; ditto to Dunkirk, 140 miles, 4 frs.; ditto to Strasburg, 460 miles, 11 frs. 20 c.; ditto to Antwerp, 130 miles, 3 frs. 45 c. In 1868, 1,690,800 tons of goods, chiefly coals from Belgium to Paris, passed on the canalised river l'Oise. On the River Seine there were no less than 2,741,400 tons carried; on the River Schelde, from Cambrai to the Belgian frontier only, 1,175,600 tons,

and on the River Aa, from St. Omer to Gravelines, 375,300 tons.

The Canal lateralle à la Garonne and the Canal du Midi unite the Atlantic and the Mediterranean. The locks are 27 metres long, and 5·80 metres wide, with a depth of 1·60 metres. The height of the bridges, which are fixed, is 2·72 metres. A detailed account of a voyage through this navigation, in the steam yacht *Miranda*, was given by its owner, Admiral Lord Clarence Paget, K.C.B., in the *Journal of the Society of Arts*, April 14, 1882.

The average effective depth of the French canals is about five to six feet, with the exception of those routes lately improved, great attention having been bestowed on the waterways from Dunkirk and Calais. The River Seine, from Rouen to Paris, has a depth, except in times of drought, of six to seven feet, but works are now going on to increase this to a little over ten feet. The locks on this river are magnificent works, their dimensions being reckoned by yards instead of feet, so that they will accommodate vessels of 800 to 1,000 tons when the improvements are completed. The bridges are fixed in France, with the exception of a few in the extreme north, and are about 12 feet high, as a rule.

The works to be consulted on the subject of the French canals, are:—"Précis Historique et Statistique des Voies Navigables de la France," &c., par Ernest Grangez, Paris, 1855; "Les Voies Navigables de l'Empire Français," &c., par Alexandre Collin, Orleans, 1865; "Etude Historique et Statistique sur les Voies de Communication de la France," &c., par M. Félix Lucas, Paris, 1873; "Tableau des Rivières et Canaux (Annexe à la Circulaire, du 9 Mars, 1867, No. 1,055) Administration des Contributions indirectes," which gives the kilometric distance from place to place throughout France; and the annual reports and statistics of the Department.

The canals and navigable rivers of Belgium have a most important influence on the commerce and trade of that country. Very many factories have water-frontage, as in France, by which the raw material and the manufactured goods are cheaply carried. Both here and in the north of France, numerous barges, laden in the autumn with sugar-beet, are constantly seen where the sugar industry is worked.

It is probable that the making and using of canals in Belgium dates to a more remote period than in any other country of Northern Europe. A chronological list of details connected with these works was most ably given by M. J. B. Vifquain, in his work on the "Voies Navigables en Belgique," Bruxelles, 1842.

The connection of the French canals with those of Belgium is—1. By Dunkirk, Bourbourg, and Furnes to Plasschendaele on the Ostend and Bruges Canal; this route has been lately very much improved and deepened. 2. By Cambrai and the River Lys to Ghent. 3. By Douai and the Schelde to Ghent. 4. By Condé and the River Dendre to the Schelde at Termonde. 5. By Landrecies, *viâ* Charleroi to Brussels, and also to Liége.

There is much traffic in the Upper Schelde from Antwerp to Ghent, the waters being tidal to the latter town, with a depth of six to eight feet, working the river with the tide. The most important ship canal is that of Terneuzen to Ghent, thirty-five kilometres in length, the lower portion of which belongs to Holland. This is used by some twenty steamers from England weekly, taking coals, pig iron, and other articles, and loading manufactured iron and other goods from all parts of Belgium. The inland harbour at Ghent has been much enlarged of late, and the lock there has been removed, thus rendering access more easy. It is now a magnificent waterway of ample depth and great width, with locks at Terneuzen on the Schelde, and at Sas van Gent, near the Belgian frontier; there is a pilot station at Terneuzen, the men taking their turns to and from Ghent. English coal may be bought for fifteen to eighteen francs a ton at Ghent, being carried at a very low freight for want of cargo on the outward voyage. Vessels of the following dimensions can use this canal:—Length, 110 metres; breadth, 11·50 metres; and draught, 5·85 metres. Their speed *en route* when exceeding 2·75 metres draught, 145 metres a minute; when under 1·50 metres draught, 250 metres a minute. These, with other regulations, were authorised by decree of 11th August, 1885.

The ship canal from Ostend to Bruges has fifteen feet of water, but a depth of seven feet only is found from the latter city to Ghent. There is some coal and local traffic on this system, but of no very great quantity.

The River Rupel, which is about twelve miles above Antwerp, leads from the Schelde to Willebrock, opposite the town of Boom. From here a canal with five large locks leads to Brussels. This canal, which had its origin in the year 1415, but which was only completed in 1561, is of much importance. The traffic on it is heavy, and it is worked by the

Corporation of Brussels, the result leaving a large annual profit. The tolls on this canal are—First-class, ·06 franc; second-class, ·04½ franc; third-class, ·02 franc per ton; in all cases a cube metre is reckoned as 1,000 kilogrammes or a ton. In the first-class is reckoned merchandise, &c.; in the second-class, bricks, firewood, stone (wrought or unwrought), salt, &c.; and the third-class, unladen vessels.

There is a depth of from somewhat over 10 feet of water, but this is limited to an effective depth of 3·10 metres where it passes over a small stream by a brick aqueduct. A line of steamers belonging to Messrs. Thomas & Co., of London, runs to Brussels regularly, and several Dutch lines of steam barges use this route. Sailing vessels and lighters are worked on the canal by means of the chain system, with *remorqueurs*, 20 to 30 being thus easily towed. The locks are very large, and many vessels pass at the same time, and the trains are made up accordingly. When two meet, the ascending tug drops the chain, the train keeps on its right side, and the chain is again picked up by a grapple when the descending train has passed. With this system the vessels steer with the utmost ease, all having men at the helm. When approaching a lock the chain is thrown off in proper time, and the vessels' way being checked, they gradually settle side by side in the lock. Great skill and care is used by the men, damage by collision rarely occurring. A great advantage attends this system of towage, as the tugs make no wash, which so much destroys the banks of canals. The tolls are light, and the rates for towage very small. Empty vessels pay only 20 c. for a *laissez passer vide;* this ticket, as in France, can be taken from any *bureau de navigation* to any other place in the kingdom or in the Republic.

Inland navigation in Belgium is under the Minister of Public Works. The last rules were published in the *Moniteur Belge* of May 3rd, 1881, No. 123, a copy of which the man in charge of any vessel must provide himself with. The passage of certain bridges and of all locks must be made between certain hours, according to the time of year; in the mid-summer, 4 a.m. to 9 p.m., and in mid-winter, 7 a.m. to 5 p.m. These rules are very detailed, and among them are those for regulating the speed of steamers to so many metres a minute, according to the draught of the vessels, to prevent damage being done to the banks by the wash of the swell raised. The railway bridges are not opened after 20 minutes before the passing of a train, when the round red signal is lowered to show that the bridge is closed. These bridges are nicely balanced, so that two men can with the greatest ease and dispatch open them by aid of cog-wheels working on rack-work.

The general rules are divided into four sections:—1. Those applicable to vessels, rafts, and trains of timber, giving the conditions under which these are permitted to use the navigations, with those relating to vessels *en route*, the "patrons," or those in charge, the passage of locks and bridges, the mooring of vessels and of the *chômage*, or stoppage of navigation for repairs of the canal (which is duly announced a month previously), the loading and unloading of goods, the transport of powder and explosives, the navigation dues and draught of the vessels. 2. The special rules applicable to vessels working a regular and constant service, steamers, tugs, and trains of vessels towed by a *remorqueur* by aid of the chain system. 3. The conservation of the navigable ways and their dependencies. 4. Penalties, the officials charged with the management, *procès verbaux*, &c. These rules are very similar to those in force in France, but in the latter country they are more rigidly enforced. Order is thus preserved, and it is rarely that any difficulties occur between those engaged in navigating the various rivers and canals.*

In Holland the carriage of goods is chiefly by water; almost every town and village has water communication which enables the weekly markets in the various centres to be supplied with farm produce and goods by the market vessels, which have their regular stations, for which they pay dues to the town authorities. A small toll of 1d. or ½d. is also paid at the bridges, which all open, thus aiding the communal rates. At the sluices or locks tonnage rates are paid, but these dues are comparatively light.

The Dutch Government has greatly improved the inland navigation in the past twenty years, the rivalry of Amsterdam and Rotterdam having given occasion for a vast expenditure in improving the access to these important cities for the large steamers of the present day. The most important of the new ship canals in Holland is the North Sea Canal, for which a new harbour was formed at

* Many detailed particulars of canal navigation are given in "Through France and Belgium, by River and Canal, in the Steam Yacht *Ytene*," by W. J. C. Moens. 1876.

Ijmuiden, the *duinen* being pierced to give access to the waters of the Ij, which were deepened and contracted, much valuable land being thus reclaimed. In the outer and inner harbour and in the main-canal there is water for vessels of 6·50 metres draught, but in the canal east of Amsterdam this depth is reduced to 3·50 metres, and in those leading to Spaarndam for Haarlem, Leiden, &c., it is only 3 metres. The "General regulations of police, and tariff of the canal and harbour dues for the North-sea Canal, its harbours and branch canals," with a plan, &c., according to a resolution of October 26th, 1876, signed by the King of the Netherlands, are published by Wed. J. Ellerman, Amsterdam, price 50 cents.

This canal, communicating with the Zuyder Zee (where there is from two to three fathoms) by the great sluices at Schellingwoude, unites with the old North Holland Canal by the sluices or locks at the Tolhuis, opposite Amsterdam; all these locks, as is the case in all ship canals in Holland, are in duplicate, one being for large vessels and the other for the smaller inland tjalcks or market boats. By an ordinance of August 6th, 1880, new police rules for the North Holland Canal, which enters the sea at Nieuwediep, were authorised. Vessels drawing 4·80 metres, and at times 5 metres, can use this navigation, which, however, has lost its importance since the new North Sea Canal has been opened. A certain number of timber ships still discharge their cargoes at Purmerend, which are floated to Edam and there sawn into deals and planks. Numerous passenger steamers ply from Amsterdam to the towns of North Holland by this route, where the locks at Tolhuis and Purmerend are worked with great smartness, the delay being only a few minutes. As on other canals, the speed of steamers is regulated according to their draught, varying from 125 metres a minute for those over 2·75 metres draught to 250 metres for those of not more than 2 metres.

The ship canals communicating with Rotterdam are numerous, being

1. The Voorne Canal running from Helvoetsluis through the Island of Voorne to the River Maas. The resolution of March 9th, 1880, resettled the police regulations for this route; the maximum dimensions of vessels using it being—length, 110; beam, 13·70; draught, 6 metres.

2. The Niewe-waterweg, or direct entrance from the North Sea to the Maas, which is without sluices, and is cut through the Hoek van Holland, thus forming a new outlet to the Maas.

Besides these approaches, there is another route to Rotterdam, to which great attention has been paid of late years, but the railway-bridge across the river at Rotterdam causes a certain inconvenience to vessels using it. Vessels coming from the sea by the Hollandschdiep, enter the narrow passage of the Kil near the great Moerdyke railway-bridge, and passing Dordrecht, the Maas is reached above the Rotterdam railway-bridge. The Nieuwe-Haven, just above this bridge, is a most convenient port for small steam-yachts visiting Rotterdam.

There are two other important ship canals, giving access from the River Schelde to the inland waters of Holland:—

1. The Walcheren Canal, about seven miles long, from the new port of Flushing to Veere, which place, formerly known as Campvere, was a free port of the Scotch, who had a factory, or trade station, there for 300 years, from the year 1506. The maximum dimensions for vessels using this canal are:—Length, 120; breadth, 19·75; and draught, 7·10 metres.

2. The South Beveland Canal, from the West Schelde at Hansweert to the East Schelde at Wemeldinge, is five miles in length. The regulations of this canal, fixed by the resolution of May 28th, 1880, allow vessels of the following dimensions to use it, viz., length 100, breadth 15.75, draught 6.20 metres.

The former of these two canals is but little used, but there is a great traffic of the large Rhine arks, and the inland steam barges and sailing vessels of Holland, going to and from Antwerp, Brussels, Ghent, and other towns of Belgium. The locks, like the others in the more important canals, take in 30 to 40 of these vessels at once, all masters having to show their papers before passing. These ship canals are all State property, and are under the management of the Minister of the Waterstaat, Trade and Industry. Many of the smaller inland navigations are under State control, but others belong to the communes through which they pass. The water level, which is so all-important in the Netherlands, is regulated by the Amsterdam mark, called the A.P. (Amsterdamsche Peil).

The following navigations, with some others, are also regulated by police rules, fixed by resolutions of the State:—

1. The Afwaterings Kanaal, from the Noordervaart and the Neeritter, near Venlo, for

vessels—length, 24; breadth, 3·70; draught, 1 metre. The use of steam is forbidden.

2. The canalised River Ijssel, from the River Lek, opposite to Ijsselmonde, to Gouda, whence there is canal communication with the River Amstel, to Amsterdam, and also by the old Rhine, *viâ* Leiden and Haarlem, to Spaandam, to the North Sea Canal. There is a great traffic in the former of these two routes, there being always a great collection of craft at the sluices at Gouda, waiting their turns to pass. Large and improved locks are urgently required at this place. The depth of water on this route is at least six feet.

3. The Keulsche Vaart, from Vreeswijk, on the River Lek, *viâ* Utrecht, the Vecht and Weesp, to the River Amstel, and Amsterdam. Vessels of a breadth of 7·50 metres, and draught of 2·10 metres, can use the route; the sluices take in the very long Rhine craft. The pace allowed for steamers is 130 metres a minute for those of 1·50 draught, to 180 a minute for those of 1 metre draught.

4. The Meppelerdiep, Zwaartsluis to Meppel, for vessels of length 60, breadth 7·80, draught 1.80 metres.

5. The Drentsche, Hoofdvaart and Kolonievaart, from Meppel to Assen, for vessels drawing 1·60 metres, between Paradijssluis and Veenebrug, in other parts only 1.25 metres.

6. The Willemsvaart, from the town canal at Zwolle to the River Ijssel, by the Katerveer, for vessels of length 100, breadth 11·80, and draught 3 metres.

7. The Apeldoorn Canal, from the Ijssel at the sluis near Dieren to the same river at Hattem, for vessels of length 30, breadth 5·90, and draught 1·56 metres.

8. The Noordervaart, between the Zuid Willemsvaart at sluis No. 15 and the provincial canal at Beringen, in the commune Helden, for vessels of length 51, breadth 6, draught 1·50 to 1·65 metres.

9. The Dokkum Canal, from Dokkum (in Friesland) to Stroobos, and the Casper Roblesdiep or Kolonelsdiep, being the inland route from Friesland to Groningen. Vessels must not exceed 5·50 metres breadth and 1·60 metres draught on this route, but by the Dokkumerdiep, on the sea-coast, and entering again at the new sluice at Zoltkamp, vessels drawing eight feet can go to Groningen from Harlingen *viâ* Franeker and Leenwarden. The dairy farms of Friesland are much benefited by the network of canals intersecting this province, by which their butter is conveyed by small boats to the markets held in all the small towns, thence it is conveyed twice a week in steam barges to Harlingen, from which port it is shipped at once to the London and other markets. Friesland can also be entered at Lemmer, on the south side of the province, whence Leeuwarden can be reached *viâ* Sneek, but there is not more than five feet water in some places. These routes are being improved by the State. From Groningen there is a deep water canal to Delfzijl, in the estuary of the River Emms, by which the inland navigation of Germany may be entered. The Baltic is thence reached by means of various rivers and canals.

There is another excellent canal from the Lek at Vianen, opposite Vreeswijk, to Gorcum on the Waal.

Space fails to detail the many other canals and navigable rivers of France, Belgium, and Holland, to say nothing of the vast River Rhine, the navigation of which is much improved of late years. The inland vessels using this latter river have increased enormously in size, and are to be measured by yards instead of feet, as our small barges are in England. Coal from the Ruhrort mines is brought by them so cheaply to Holland and Belgium, that at Amsterdam it sells from 1s. to 1s. 6d. per ton cheaper than English coal; this may account in some way for the present want of elasticity in our export of this article. At all the ports of the above three countries, which are connected by inland navigation with towns, there are pilot stations, with an ample supply of qualified men, for whose services charges are made according to the draught of vessels requiring their services. On inland rivers the supply depends on the demand; these men are very able, well knowing their business. On the Rhine the pilots only take charge of vessels in their own districts.*

The great feature of the almost perfect system of inland navigation abroad, and which at once strikes Englishmen, is the vast scale on which it is constructed, and the ever increasing size of the barges and lighters. On the Rhine and in Holland vessels of 400 tons are commonly seen, and some of the lighters at Rotterdam are of 1,000 tons. All these, as the smaller barges of France and Belgium, have shifting hatches for the whole

* A somewhat detailed account of "Through Holland by River and Canal in the Steam Yacht *Ytene*, R.V.Y.C.," was published in the *Field* newspaper of February and March, 1879.

length of the vessel, with the exception of those parts occupied by the forecastle and stern. The accommodation for the captain and men are excellent, and the gear and paint-work is maintained in a perfect manner. These vessels are as far superior to ours as their canals are to our canals. No useful details of canal organisation can be prepared without a careful study of the arrangements abroad. Holland has, for its size, by far the greatest inland water carrying power, Belgium follows; the physical conditions of France approach more nearly those of England, and it is probable that a similar system, on the French lines, would be found the most practicable for adoption. Water vegetation is found a great hindrance to the use of steam, unless the chain system with *remorqueurs* is adopted. It is found that constant traffic much prevents the growth of weeds, and it is on disused routes that these are chiefly found. In Holland steam barges of about 200 to 300 tons are fast supplanting the sailing craft.

Mr. U. A. Forbes, quoting the report of the House of Lords' Committee on Conservancy Boards, 1877, states that we have 210 rivers in England and Wales, 44 of which have been made more or less navigable, and that of 4,332 miles, constructed at a cost of £14,000,000, the railway companies have acquired 1,700 miles, thus throttling the system. He further tells us that a large portion of the large expenditure on canals, which is now valueless, might even yet be recovered by a more enlightened management.

It is evident that a reconstruction of the Thames and Severn Canal on the lines of the foreign canals, with locks of a sufficient size to take several barges, of say 250 tons, to be towed by the *remorqueur* system, would be found as advantageous to the coal owners of South Wales as to the consumers in London. A comparison with the freights abroad show that this coal could be carried at about 3s. to 4s. a ton. Many towns could be connected by waterways to sea ports, thus lightening the carriage of goods.

Money and land were never cheaper, the labouring classes are crying out for employment; could, therefore, confidence be once more felt in the possibility of a profitable working of inland navigation, a great step would be gained by reviving a system of carrying goods once much thought of in England, and still profitably used in many foreign countries.

IMPROVEMENTS IN CANAL COMMUNICATION.

By Samuel Lloyd.

When I was asked to prepare a paper upon canal communication for the British Association in Birmingham, in September, 1886, I prefaced it with a short history of canal navigation; but the present and future aspects of the question were considered so much more important, that I was requested to leave the past and confine my remarks to the pressing and immediate needs of the country. By those well qualified to judge they were then considered pressing and urgent, and how much more so now, after two more years of neglect and of foreign competition.

So dense and difficult to move is the public mind, that it generally takes 20 years to convince it, however good the proposed measure may be; but now events move quickly, and a conference like the present is of great value, as it elucidates information and expedites necessary changes that would be long delayed if left to isolated individual exertion.

The advantages of improved water communication, and its necessity for the welfare of the country, are so manifest to all who look into the question, that it is to be regretted that so many should excuse themselves from doing so. Members of Parliament hold back because they lack information, and the subject has not been brought before them by their constituents. Constituents hold back because if anything could be done they conclude their members would have attended to it. Some say it is too late, it ought to have been done before, other politicians aver it is too soon, it is a coming question, but the country is hardly ripe for it. They prefer not to be pioneers, but to wait till preliminary work has been accomplished by others; they have no time to attend to it.

As a proof that public authorities recognise the importance of the question, the Birmingham Chamber of Commerce, in 1885, declared "the exorbitant cost of carriage of goods" to the seaboard to be one of the special circumstances affecting the depression of trade in the Midland districts.

On the 5th April, 1887, the Birmingham Town Council passed this resolution:—"That this Council deems it to be of the utmost importance to the trade and commerce of Birmingham and the surrounding district that improved canal communication should be opened up, which should connect this great

centre of industry with the sea," and decided that "A special committee be appointed to confer with this Council as to the merits of any scheme for improving the canal communication with London, Liverpool, or other ports."

At the conclusion of the report of the Canal Inquiry Committee then appointed, which was presented to a special meeting of the Council on the 20th March, 1888, it is stated, "After carefully considering the whole matter, your committee desire to express their opinion:—

"I. That it is in the highest degree important that canal communication with the great ports of the country should be greatly improved, so as to provide for the transit of both imports and exports by water, at very much lower rates than now prevail, and as a check to the excessive cost of railway carriage.

"II. That while it is highly desirable that this improved communication should be created with London, Liverpool, Hull, and the Severn Ports, yet, as far as the information of your committee extends, the ports of London and Liverpool are of far greater importance to Birmingham traders than the Severn ports. This is proved, not only by the general consensus of opinion on the subject, but by the replies received to the series of questions already referred to. (Questions addressed to the merchants and manufacturers of Birmingham and the district to ascertain their opinion from actual experience of the need of improved canal communication.)

"III. That in those answers, the reasons assigned for the preference given to London and Liverpool appear to be valid and conclusive. . . . .

"IV. That, with regard to exports, in many cases the shorter time consumed by railway than by canal transit determines in favour of the former; and it must be remembered that a large proportion of the merchant exports from Birmingham consist of mixed goods, of comparatively light weight, on which the cost of carriage is not an exceedingly important item.

"V. That, with regard to imports, time does not appear to be of the same importance, and (partly, perhaps, owing to this reason) a much larger proportion of imports is received *viâ* the Severn route.

"Your committee desire to express, in the strongest manner, their opinion that the industries of the town and neighbourhood are very seriously affected by the high rates of carriage. . . . .

"In conclusion, your committee are of opinion that should the work be carried out by a private company, there seems no certainty that it might not be ultimately absorbed or controlled in the matter of rates, or otherwise by the railway interests. The plan, therefore, of carrying out the work by means of a public trust, appears to your committee most likely to ensure and preserve the interests of the town, and secure the lowest possible rates to traders and consumers; and it is probable that with such a trust, under the operation of a sinking fund, the capital account being ultimately extinguished, the canal might become almost free, such tolls only being levied as would be sufficient to provide for its maintenance. Your committee, therefore, recommend that they be empowered to take such steps as may appear desirable to induce the Government either to insert clauses in their Railway and Canal Traffic Bill, or to introduce a separate measure authorising the formation of canal trusts."

The recommendation has been adopted by the Birmingham Town Council.

The importance of main highways has always been recognised. The Romans acted upon this principle, intersecting the country with main and direct roads, to which other roads and lanes acted as feeders, and at the beginning of this century the road termed the Holyhead-road was made to unite England and Ireland more closely together. Again, upon the introduction of railways, after the Liverpool and Manchester line had been opened, a main route connecting these towns with London, *viâ* Birmingham, was constructed, and immensely promoted the commercial prosperity of the country. It is on this principle that it is proposed to intersect the country with one good through canal route, connecting the Rivers Thames and Mersey, and another connecting the Severn and Trent. Of these, the route from London to Liverpool is primarily important, and should be first constructed, and the other as quickly as possible afterwards. The population of the Midland counties number about 2,000,000, and there are upwards of 10,000 manufactories and workshops in Birmingham and the Black Country alone, not including those in the large pottery districts of North Staffordshire. The following is the calculated per-centages of goods shipped from Birmingham and the district at the various ports:—

From Liverpool	43	per cent.
,, London	40	,,
,, Hull	10	,,
,, Severn Ports	3	,,
,, South Wales	3	,,
,, Harwich, Grimsby, &c.	1	,,
	100	

From this calculation it is evident that the improvement of the waterway from the Thames to the Mersey is the most important for the land-locked districts of mid-England. With London and its great local and foreign trade at one end, and Liverpool and all the industries of Lancashire at the other, and Birmingham, the workshop of the world, with the immense variety of the manufactures of Staffordshire in the centre, and with the coal-fields of Warwickshire, North and South Staffordshire, Cheshire, and Lancashire, along its route, who can doubt the success of the undertaking, under proper auspices? Commerce that has long languished would be revived, new trades would be created, and the resources of the country generally developed, in a manner that by any other means would be impossible. At present various companies own the canals between London, Birmingham, and Liverpool, and with different-sized locks, and different tolls and regulations, their disjointed condition has been very detrimental to through traffic. These waterways have been described as "an enlarged ditch, five feet in depth, with a top water of thirty feet, and inclined slopes of mud on each side, which have a constant tendency to silt and fill up." Moreover, they were not intended for direct communication. Towards the end of last century, when canals appeared to afford a lucrative opening for the employment of capital, many short links were cut to suit the purposes of various towns in the country, and these were afterwards connected, but form very circuitous and indifferent through routes. During the last forty years many of the canals have been acquired by the railway companies, and have been managed, and in some instances allowed to become derelict, to suit their own purposes. The Birmingham Canal and others came under the control of the London and North-Western Railway during the railway mania of 1846, and the company argue that they are not in a worse condition to-day than before they came under their management.

This may be so, but progress is the law of our nature and of the world. If the railways had been kept in accordance with their "original purposes" of merely carrying heavy goods, with horses as the motive power for passenger trains,* where would our gigantic and well-ordered railway system have been? Where would our great naval and maritime ascendancy have been if our vessels had been kept to the size of the one in which Christopher Columbus crossed the Atlantic, or even as they were 40 years ago, when Sir Charles Lyell went to America in a very fine paddle-boat of 1,200 tons burthen?† Who would think of sailing now in such a paddle-boat, when the magnificent liners of 5,000 to 6,000 tons burthen are daily crossing the ocean?

Within the last few days it has been reported in the papers that "the London and North-Western Railway Company have decided upon a very important experiment with regard to their canal traffic. The company own the Shropshire Union Canal, and they have determined to try the effect of having locomotive engines to draw the canal boats instead of horses. Orders were received at the Crewe Railway Works last week for the construction of several engines of a small pattern to run on sets of rails to be laid alongside the canal. New canal boats are also being built. The experiment will be made between Chester and Shrewsbury." This is a step in the right direction of utilising steam-power for the transit of heavy goods, but will not alone meet the great need of the country.

For the four tidal rivers—the Thames, the Mersey, the Severn, and the Trent—to be united by a modern canal, making use of the natural advantages given to us in their position and in their tides; the requisite existing waterways should be acquired—either by the State, or a properly-constituted trust—and new lengths cut where necessary, so that the whole may make a good through route, adapted to the advantageous use of steam-power. Our climate, rainfall, soil, and the distance between the rivers, are all favourable to the scheme. The depth of the new or national canal should be 4 or 5 feet deeper, and about six yards wider, than the canal route at present—say, not less than 8 to 10

* When the Stockton and Darlington Railway was projected, the intention was to use horses as the motive power, and they were so used for passenger traffic. It was not for more than five years after the opening of the line that locomotives were used for passenger traffic.

† The *Britannia*, one of the Cunard line. It reached Boston from Liverpool in 14 days and 22 hours. (Second visit of Sir C. Lyell, F.R.S., to the United States, 1845-6. John Murray).

feet deep, by 70 to 100 feet wide—and it is essential that it should be managed as one undertaking.

Birmingham is 400 feet above the sea, and from whichever port it is approached, this difference in level has to be overcome. At present, water-locks are used, of which there are no less than 157 between Birmingham and Brentford. They are perfectly effete, and unsuitable for a main through route. Immense advances have been made in canal construction, and physical obstacles can be easily overcome that were formerly quite out of the range of engineering practice. Several canal-boats can be raised simultaneously from one level to another, in less than two minutes, by the use of hydraulic power, without loss of water, and very economically, and thus the difficulty of the difference in level is solved. The drawings exhibited show hydraulic lifts that are now in operation. They are very similar to the one at Anderton, but, like it, too costly for general adoption. Great improvements upon them can however be made, and those proposed for the main canal route, between the four rivers and ports, combine simplicity, efficiency, and economy of construction. Moreover, they will enable the route to be available for any size steamers desired up to 600 tons burden, and, consequently, for Government use for the defence of the country, as gun and torpedo boats could steam along its course and issue forth, should a blockade of any one of the ports be attempted*.

The Severn, at Worcester, is not more than 62 feet above the Trinity high water mark, and the Trent, at Burton, is not more than 112 feet above the same level, and it is no great distance, as the crow flies, between the two places. Birmingham, and the greater part of the South Staffordshire district, are all in the basin of the Humber, and are drained by the southern tributaries of the Trent. Water runs from them all, in one continuous and gentle descent, to Burton, to which place, at comparatively small outlay, the Trent may be made navigable for 300-ton barges. There are no engineering difficulties in this direction between the Midland Counties and the sea. It is not proposed that boats carrying goods should proceed at a greater speed than five miles an hour, so that no difficulty will arise from too great a wave of water. Canal traffic is now sometimes suspended for days together in winter by frost and snow. Upon the improved canal this would never be the case, for the thin film of ice formed on the water during a night's frost would be broken into fragments by the first steamboat passing in the morning.

The greatest danger to our commerce, and which threatens materially to affect our prosperity, arises from foreign competition, and this can only be effectually averted by a cheap mode of internal transit. Improved facilities for the transfer of raw materials from one centre of manufacturing industry to another would vastly stimulate the trade of the country, as with the present competition manufacturers cannot thrive without obtaining raw materials at the lowest possible cost. While the iron-masters of Liege and Seraing get their imported ores brought from Antwerp by water, 105 miles, for 2s. per ton, and their manufactured iron and steel conveyed to Antwerp for export at the same low cost, the rate paid on English iron from South Staffordshire to London is about 14s. per ton. The corresponding rate would be 3s. per ton. The trade of Antwerp has increased sixtyfold in recent years. Between 1865-85 the tonnage of the port has increased from 609,353 to 3,993,527 tons, or over 650 per cent. Iron is delivered from works in the middle of Belgium to London at a cost of 5s. per ton for carriage, though this has to include canal dues, port dues, sea freight, and insurance. Germany and France are equally alive to the need of cheaper transit, and we are continually being forced out of the market by this foreign competition. Foreign goods are often delivered to Mid-England at proportionately lower mileage rates than from English manufacturing firms; for instance, a Birmingham purchaser of glass was accustomed to have it from London, and the carriage by rail to Birmingham was 25s. per ton; when he was offered foreign glass, the rate from the foreign works to Birmingham was 20s. per ton, and the glass suited him quite as well, and he has bought from abroad ever since. The action of carriers in this, and many other like instances, is, to say the least, unpatriotic. If canal transit by the aid of steam-power was not the most economical for merchandise in bulk, the Americans would not have recently constructed a canal between Lake Superior and Lake Huron. Along this canal an immense traffic passes. The returns for 1886 show that from April 25th to December 4th (the period during which the canal was open to navigation) 4,220,000 tons passed

* See p. 51, "A National Canal, a National Necessity," by S. Lloyd. (London: James Hogg and Sons, 7, Lovett's-court, Paternoster-row, 1888.)

through—a greater monthly traffic than that of even the Suez Canal. The populous centres of industry in Mid-England are languishing for want of work. Tens of thousands are in a state of semi-starvation, and it is not only workmen and employers who are suffering, but the shopkeepers and other classes, for the prosperity of the one is the prosperity of the other. Emigration is advocated, but however advantageous, in some cases it may be, this should not stop the development of the country. A national canal would encourage the existence of a large inland population; many favourable sites for industrial villages would be found along its course, the rateable value of hundreds of square miles would increase, and the immense amount of new traffic already alluded to, the inevitable result of improved facilities of trade, would be brought into existence to the great advantage of the country generally.

The cost of the proposed national canal may be roughly estimated as £20,000,000; from £8,000,000 to £12,000,000 would be the cost of acquiring the requisite canals, and £8,000,000 to £12,000,000 the cost of adapting them. The test question put will be—will it pay? As the answer that it would pay, both commercially and nationally, may be challenged, it is most desirable that Government should look into the question, and if they could be induced to do so, and obtain a report upon the subject, the result would be information that might prove of the greatest use should legislation afterwards be found to be desirable.

THE LAW OF CANALS.

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The object of this paper, which has been prepared at the request of the Secretary, is merely to put before the Conference, in a concise and convenient form, the existing law with regard to canals, and to indicate the alterations which it is proposed to effect by the Railway and Canal Traffic Bill now before Parliament. The law here stated is confined to such enactments and decisions as directly concern canals; and thus the decision of the Courts as to those provisions of the various railway and canal Acts which affect both railways and canals alike, the general law relating to carriers, and other like matters which would find their place in a legal treatise on the subject of canals, are not touched upon.

Sources of Canal Law.

The law relating to canals is to be found in a large number of local Acts, in a very small number of public Acts, and in the decisions of the Courts.

As the construction and the maintenance of the water supply of canals involve the compulsory acquisition of land and of water rights, it is necessary that they should be carried on under Parliamentary powers. These are conferred, in the case of individual ventures, by local Acts which contain provisions applicable to the particular circumstances of each case. These Acts also contain some necessary general provisions, *e.g.*, those empowering the undertakers to charge and enforce payment of specified tolls, and to make bye-laws for the regulation of the navigation of their canals. The powers conferred by these local Acts are strictly limited to such as are plainly given by them, any ambiguity being held to operate against the undertakers and in favour of the public. Some instances of this will be referred to presently, when we consider tolls and bye-laws.

There are a number of decisions of the Courts which have reference to canals; but there are very few to which reference need be made in this paper. The majority of decisions are upon particular provisions in the local Acts of individual companies, and though of interest and importance to the lawyer, do not affect those general considerations with which we have here to deal.

The law with which we shall be almost entirely concerned is that contained in the Public General Statutes relating directly to canals. Those statutes are but nine in number; they are:—

3 & 4 Vic., cap. 50 (Canal Constables, 1840).
8 & 9 Vic., cap. 28 (Power to vary tolls, 1844).
8 & 9 Vic., cap. 42 (Power to be carriers, 1844).
10 & 11 Vic., cap. 94 (Borrowing powers, 1847).
17 & 18 Vic., cap. 31 (Railway and Canal Traffic Act, 1854).
21 & 22 Vic., cap. 75 (Restrictions on Leasing. 1858).
36 & 37 Vic., cap. 48 (Railway and Canal Traffic Act, 1873).
40 & 41 Vic., cap. 60 (Canal Boats Act, 1877).
47 & 48 Vic., cap 75 (Canal Boats Act, 1884).

These statutes exercise a general restraining

and extending power over the provisions of the various local Acts, and it is in them that the existing law is practically contained. Accordingly, in the sequel, little more is done than to collect together and arrange their scattered provisions, under appropriate and consecutive headings, and to condense and simplify their language.

Canal Companies and River Trustees.

It will be seen that in some of the provisions of these Acts, reference is made not only to canal companies but also to trustees of navigable rivers. It need here only be pointed out that in many respects the legal positions of the two classes of persons are totally distinct. A canal company is a private venture, having private pecuniary profit in view; while trustees of navigable rivers are persons exercising a public trust for the benefit of the public alone.

Canals and Railway Companies.

A very noticeable point is the distinct recognition by Parliament of the danger to public interests occasioned by the control which railway companies have obtained over canals. The provisions by which it has been attempted to guard against an increase of this influence, will be stated when we refer to leases of canals, their maintenance, traffic, and tolls.

Soil of Canals.

Under the local Acts the ownership of the soil of the bed of canals and towing-paths is usually vested in the undertakers, but this is not necessarily so. There are cases where nothing more than a mere right of way is possessed by the company.

Leases.

It would seem proper to make early mention of the powers and restrictions which exist with regard to the transfer to others of the rights possessed by canal companies. The Statute 8 & 9 Vic., cap. 42, authorises canal companies, after giving proper public notice, to lease to any other canal company by a lease to take effect within six months, and to be for a period not exceeding 21 years, any part or all of the tolls which they take upon their canals or connected rails or tramways. The lessees are to be deemed to be the collectors of the tolls, and are to have all powers of collection.

But in accordance with the policy which seeks to prevent railway companies from acquiring an injurious control over competing canal traffic, the Statute 21 & 22 Vic., cap. 75 (which is made perpetual by 23 & 24 Vic., cap. 42), makes it unlawful for any such lease to be granted to a canal company which is also a railway company, or is authorised to work any railway constructed under an Act, except under the express authority of some Act passed since August 2nd, 1858.

In aid of the policy of this provision, there is a Standing Order of the House of Commons, No. 156, that "No railway company shall be authorised to construct or enlarge, purchase or take on lease, or otherwise appropriate, any canal, dock, pier, harbour or ferry, or to acquire and use any steam vessels for the conveyance of goods and passengers, or to apply any portion of their capital or revenue to other objects distinct from the undertaking of a railway company, unless the Committee on the Bill report that such a restriction ought not to be enforced, with the reasons and facts upon which their opinion is founded."

Maintenance of Canals.

There is, it has been held, a common law duty imposed on canal companies to take reasonable care to prevent danger to navigation, and therefore they must either remove, or give proper warning to passing vessels of the existence of sunken vessels which ought to have been removed by their owners. Local Canal Acts frequently contain provisions compelling the undertakers to guard against danger to the public by erecting proper fencing where there is likely to be any accident, owing to the proximity of public highways; but even where there is no such express provision, they are by law bound to take proper precautions in the matter. But, in the absence of negligence, they are not liable for injuries caused to others by flooding from their canals owing to excessive rain.

Every railway company owning or managing all or any part of a canal is required by 36 & 37 Vic., cap. 48, to keep such canal, or part, and all reservoirs, works, and conveniences belonging to it, thoroughly repaired and dredged, and in good working order, and to preserve the supplies of water, so that the whole of such canal, or part, may be at all times kept open and navigable for the use of all persons who desire to use it, without unnecessary interruption.

With regard to injuries caused to canals, it has been held that, where the banks of a canal give way in consequence of an adjoining owner having dug pits below them, the com-

pany were not entitled to recover against him, unless they proved that the banks of the canal at the spot were in good repair.

It will be sufficient here merely to allude to the existence of the Statute 3 & 4 Vic., cap. 50, which enables canal companies to obtain the appointment of constables, recommended and paid by themselves, for the preservation of the peace on their canals.

Traffic.

By 8 & 9 Vic. cap. 42, canal companies and trustees of navigable rivers may provide vessels for use of other persons, both on their own canals and rivers, and also on other canals or rivers communicating directly or indirectly therewith.

They are also authorised by the same statute to enter into agreements with each other as to the passage of their vessels over each others canals or rivers, and as to the haulage of those vessels. But by 36 & 37 Vic., cap. 48, no such agreement is allowed to be made after July 21st, 1873, the effect of which is to give control over, or the right to interfere with, the traffic over any part of a canal to a railway company, or any persons managing or connected with the management of any railway; unless the sanction of the Railway Commissioners (see p. 851) has been obtained to such agreement. There must be public notice given of such agreement before it is so sanctioned, so that objectors may be heard, and it is expressly provided that the agreement is not to be sanctioned by the Commissioners if, in their opinion, it would be prejudicial to the interests of the public.

By 17 & 18 Vic., cap. 31, and 36 & 37 Vic., cap 48, railway and canal companies are bound to give reasonable and equal facilities for the receiving and forwarding and delivery of traffic, whether through or local.

By 8 & 9 Vic., cap. 42, canal companies and trustees of navigable rivers may enter into agreements with each other as to the haulage of boats over each others canals and rivers. And they may provide, for persons desiring the use of them, man, horse, steam, or other power for hauling vessels, both on their own canals and rivers, and also on other canals or rivers communicating directly or indirectly with them.

Bye-Laws.

Local Canal Acts usually contain provisions empowering the undertakers to make bye-laws for certain purposes. The power to make such bye-laws is strictly confined to that expressly granted by the words of the Acts. Thus, where in a local Act power was given to make bye-laws "for the good government of the company, and for the good and orderly using the navigation, and all warehouses, wharves, passages, locks, and other things that shall be made for the same, and of and concerning all such vessels, goods, and commodities as shall be navigated and conveyed thereon, and also for the well-governing of the bargemen, watermen, and boatmen who shall carry any goods, wares, or merchandise upon any part of the said navigation," it was held that the company had no power to make a bye-law forbidding the use of their canal on Sunday.

Steamers.

Express statutory power is conferred by 8 & 9 Vic., cap. 42, to make bye-laws from time to time to regulate the construction, dimensions, power, rate of speed, &c., of "vessels propelled by steam by means of paddle-wheels," provided such bye-laws are made equally applicable to, and binding on all persons using such steamboats. When one company uses the canal of another, they must conform to the bye-laws of the latter with respect to the steamboats they use.

In a case decided in 1859, with reference to a screw steamer, it was decided that there is a public right to use steam power in navigating canals, provided it occasions no more than the ordinary injury to them.

By Standing Order No. 162 of the House of Commons, "No powers of purchasing, hiring, or providing steam vessels shall be contained in a Bill by which any other powers are sought to be obtained by a railway company, except when the transit by such steam vessels is required to connect portions of a railway belonging to or proposed to be constructed by such company."

Canal Companies as Carriers.

The original intention of the Legislature with regard to canal companies, was that they should merely construct and maintain their canals, and charge tolls to such persons as desired to use them; but it soon became obvious that if canal traffic was to acquire any vitality power must be given to the owners themselves to be carriers. Accordingly, the Statute 8 & 9 Vic., cap. 42, authorises the proprietors or trustees of canals or navigable rivers to become carriers upon their own canals and rivers, and upon tramways or rail-

ways made in connection therewith, under the authority of their private Acts, and also upon any other canals and rivers communicating directly or indirectly with their canals or rivers; and also to purchase, hire, and construct vessels and waggons for such purpose, and to establish and furnish steam, animal, or other haulage, and generally to take all proper steps for collecting, carrying, warehousing, and delivering goods.

As the exercise of these increased powers necessitated the acquirement of further funds, a subsequent statute, 10 & 11 Vic., cap. 94, empowered the undertakers to raise money on mortgage or bond to an amount not exceeding at one time one-tenth, or in all, one-third of their paid-up capital, for the purpose of acting as carriers, and for no other purpose.

Tolls.

When a canal is made pursuant to a local Act, the right of the proprietors to tolls is derived entirely from the Act, and is to be considered as if it were a bargain between them and the public, the terms of which are expressed in the Act; and the rule of construction is that any ambiguity in the terms of the Act must operate against the company, and in favour of the public. Thus where an Act authorised a toll of so much on every ton of iron which should pass through any one or more locks, and did not authorise any other toll, it was held that none could be charged for the conveyance of iron which passed along parts of the canal only where there were no locks. In accordance with the principle of this decision, where tolls are fixed by a local Act, there would be no power to vary them, but the Statute 8 & 9 Vic., cap. 28, authorises the proprietors of canals and the trustees of navigable rivers, notwithstanding any provisions to the contrary in their private Acts, to vary from time to time the tolls to be received by them for the use of or haulage upon all or any part of their canals or rivers, or any railways or tramways made in connection therewith, under the authority of those private Acts, provided such tolls are not raised above the limits which are imposed by those Acts, and all persons are treated equally in respect of such charges. There are, however, provisions that no tolls shall be increased where the proprietors were, on January 1, 1845, receiving the full dividend allowed by their private Acts, that any rights of adjoining landowners and others which are conferred by those Acts shall be preserved, and that where tolls are specially fixed by such Acts, with reference to traffic which passes to or from communicating canals or rivers belonging to other persons, the consent of those other persons must be obtained to enable variations to be made in such tolls.

The Statute 8 & 9 Vic., cap. 42, authorises canal companies and the trustees of navigable rivers, in addition to the tolls referred to in the previous Act, to charge tolls for collecting, carrying, warehousing, and delivering goods, as common carriers, on their own canals or rivers, and upon the railways and tramways above referred to, and also upon any other canals and rivers communicating directly or indirectly with their canals or rivers, provided all persons are treated equally in respect of such charges.

The same Act authorises the same persons to levy tolls for the loan of boats, men, and horse, steam, or other haulage, both on their own canals and rivers, and also on others communicating directly or indirectly therewith.

The same Act also authorises the same persons to enter into agreements with each other as to the payment of tolls for passing over each other's canals and for haulage thereon, and for the apportionment of such tolls for through traffic. But by 36 & 37 Vic., cap. 48, no such agreement is to be made after July 21st, 1873, the effect of which is to give control over, or the right to interfere with the traffic over, and tolls charged on any part of a canal to a railway company, or any person managing or connected with the management of any railway, unless the sanction of the Railway Commissioners has been obtained to such agreement. There must, moreover, be a month's public notice given of such agreement before it is sanctioned, so that objectors may be heard, and it is expressly provided that the agreement is not to be sanctioned by the Commissioners if in their opinion it would be prejudicial to the interests of the public.

The Statutes 17 & 18 Vic., cap. 31, and 36 & 37 Vic., cap. 48, compel railway and canal companies, at the request of any other such company to and from whose lines or canals any through traffic comes, to charge through rates, and power is given to the Railway Commissioners in case of dispute to fix such through rates. The Commissioners, in fixing such rates, may allot to any one of the forwarding companies a part of such rate less than the full rate they are entitled to charge, but in fixing it they must take into

consideration all the circumstances of the case, including any special expense incurred in respect of the construction, maintenance, or working of the route, as well as any special charges which the company may be entitled to make, and in no case are the Commissioners to fix the mileage rates at a lower rate than the company may for the time being be legally charging for like traffic carried by a like mode of transit on any other line of communication between the same points, being the points of departure and arrival of the through routes.

Canal and railway companies are, by 36 & 37 Vic., cap. 48, bound to keep at each station and wharf a book open to free public inspection, showing all the rates charged for traffic, other than passenger traffic, to and from that station or wharf, and the distances in respect of which such charges are made. The Railway Commissioners may, from time to time, on the application of any interested person, make orders with respect to any description of traffic, requiring a railway or canal company to distinguish in such book how much of each rate is for the conveyance of the traffic on the railway or canal, including therein tolls for the use of the railway or canal, for the use of carriages, or vessels, or for locomotive power; and how much is for other expenses, specifying the nature and detail of such expenses.

The Railway Commissioners.

Any person, whether a private individual or a person appointed by the Board of Trade, and any municipal or any public corporation, local or harbour board, if such corporation or board has obtained a certificate from the Board of Trade that their complaint is one which it is proper that they shall prefer, is empowered by 17 & 18 Vic., cap. 31, and 36 & 37 Vic., cap. 48, to complain of a violation by any canal or railway company of the provisions of the law as regards reasonable and equal facilities for local and through traffic, and as regards rates, and the maintenance of canals by owning railway companies, to the Railway Commissioners, who are a body of three persons, one of whom must be of experience in the law, and one of experience in railway business. The Commissioners, before taking formal action in the matter, may refer the complaint to the accused company for observation. If the matter is not put straight, but comes formally before them, the Commissioners have power to adjudicate upon it, and the order they make may be made a rule of the Supreme Court. The Commissioners have power to reconsider their decisions; and in some cases must, in others may, state a case for the opinion of the Supreme Court on points of law. There are also in the statutes referred to, provisions which enable a company which has a dispute with another, by leave of the Commissioners, to bring any such dispute which would otherwise be dealt with by arbitration, before the Commissioners in place of an arbitrator, without the consent of the other company; and other provisions which enable the Commissioners to decide any dispute to which a canal company is a party, provided all parties to the dispute consent.

The Commissioners have to publish an annual report of their proceedings for the past year.

Canal Boats.

The two statutes, 40 & 41 Vic., cap. 60, and 47 & 48 Vic., cap. 75, are by no means the least important of the legislative enactments as to canals. They provide for the proper sanitary regulation of canal-boats which are used as dwellings, and for their due inspection; and also for the education of children dwelling on board canal-boats.

We now turn to consider the changes in the law, which it is proposed to effect by the Railway and Canal Traffic Bill now before Parliament.

The Railway and Canal Traffic Bill, 1888.

The Railway and Canal Commission.

The Bill proposes to abolish the existing Railway Commissioners, and to transfer their powers to a new Commission, to be called the Railway and Canal Commission, which is to sit in either England, Scotland, or Ireland, as the cases require. The Commission is to consist of two permanent appointed Commissioners and three *ex-officio* Commissioners. The appointed Commissioners are to be appointed on the recommendation of the President of the Board of Trade, and one is to be experienced in railway business. Of the three *ex-officio* members one is to be appointed for England, one for Scotland, and one for Ireland, and the *ex-officio* Commissioner for each part of the United Kingdom is to be one of the Judges of the Superior Court of that part. The *ex-officio* Commissioner for the part of the United Kingdom in which the case is being heard, is to attend and preside.

Complaints may be made to the Railway Commission by any harbour board or conservancy authority, the Common Council of the City of London, any council of a city or borough, any representative county body which may be created by an Act, any Justices in Quarter Sessions assembled, the Commissioners of Supply of any county in Scotland, the Metropolitan Board of Works, and any urban or rural sanitary authority. Also by any such Association of traders or freighters, or Chamber of Commerce or Agriculture, as may obtain a certificate from the Board of Trade that they are a proper body to complain.

The Commission may not only hear such complaints as to contraventions of provisions of public Acts as the present Commission does, but may also hear complaints as to contravention of similar provisions in local Acts, and as to breaches of obligations towards the public imposed by local Acts.

They may also settle any disputes as to the legality of tolls, or rates for merchandise traffic. And may order reasonable traffic facilities, notwithstanding that they may be contrary to agreements entered into by companies. And may award damages to any aggrieved complainant.

They may make orders on two or more companies, to settle differences arising between them under the provisions of any agreement confirmed by a special Act, and may apportion expenses of executing works which they order. And may determine rating appeals to which railway or canal companies are parties.

An appeal is given from the Commission to the Court of Appeal, and, by leave, to the House of Lords.

Persons other than railway and canal companies, whose consent is required for any variation of tolls, are brought under the jurisdiction of the new Commission with regard to questions about such tolls.

And any company allowing traffic to pass from a canal on to any other canal or railway, or from a railway on to a canal, are to be deemed to be persons actually forwarding such traffic.

Terminals and other Tolls.

The Railway Commissioners' power of hearing and determining disputes as to terminal charges, and of deciding what are reasonable terminal charges where none have been fixed by the statute, has hitherto been limited to the case of railway companies. By the Bill, it is proposed to give this power to the new Commission in the case of canal companies also. And every description of toll or due chargeable for the use of a canal is brought within their jurisdiction.

Tables of Traffic and Rates.

Every railway or canal company is, within twelve months after the Bill becomes an Act, to submit to the Board of Trade a revised classification of merchandise traffic, and a schedule of proposed maximum rates and charges. When the scheme has been submitted to the Board of Trade, and made public in such a way as may be directed, the Board of Trade are to consider and arrange with the objectors, if any, the classification and maximum rates, and, if possible, to present to Parliament in an agreed form, that is to say, on such terms as may have been arranged between the company and any objectors, a Provisional Order, containing the proposals of the companies as thus arranged; and this Provisional Order will, if approved by Parliament, pass into law without further opposition. If the Board of Trade, however, fail to bring about an agreement, they will themselves prepare a scheme containing what is, in their opinion, a fair classification of traffic and schedule of rates and charges, and submit this scheme to Parliament. After the lapse of one session, during which the Board of Trade's report will have been before the public, it will be open to the company to apply to the Board of Trade to embody the scheme prepared by the Board of Trade in a Provisional Order; or, if the company do not take action in the matter, the Board of Trade may embody the scheme prepared by them in a Provisional Order. In either case, the Provisional Order, when introduced into Parliament, will be referred to a Select Committee, before whom the company, or any objectors, will be able to appear. In every case the classification and schedule ultimately approved by Parliament will become the classification and schedule of the company, in place of its existing rates and charges for merchandise traffic.

Undue Preference.

Inequalities of charges to different traders and districts, and difference in treatment of merchandise, founded on the merchandise being British or foreign, are to constitute *primâ facie* an undue preference, and to be prohibited; but the tribunal which deals with any case of the kind is to have power, in

addition to other circumstances which are now held to justify inequality, to take into consideration whether the preferential rates and charges, or the difference in treatment, are or is necessary to secure, in the interests of the public, the traffic, and also to direct that no higher charge shall be made to a person, for services in respect of goods carried over a less distance than is made to another person for similar services in respect of the same description and quantity of goods carried over a greater distance, on the same canal or line of railway.

Group Rates.

Companies are to be allowed, for the purpose of fixing the rates to be charged for the carriage of merchandise, to and from any place on their canals and railways, to group together any number of places in the same district, situated at various distances from any point of destination or departure of merchandise, and to charge a uniform rate or rates of carriage for merchandise to and from all places comprised in the group, from and to any point of destination or departure; provided that the distances are not unreasonable, and that the group-rates charged and the places grouped together are not such as to create an undue preference. The new Commission is to determine disputes as to this proviso.

Arrangement of Disputes.

Persons who complain of unreasonable charges for goods traffic may apply to the Board of Trade, and the Board of Trade is then to endeavour to effect an amicable arrangement between the complainants and the companies, without any form of legal process, or power of decision, and the result is to be reported to Parliament.

Publication of Tables, &c.

There is to be a free inspection of the classification table of merchandise at every station from which merchandise is carried, and the table is to be on sale at a price not exceeding one shilling at the principal office of the company.

Any person interested in the carriage of merchandise is to be entitled, on application to the secretary of the company, to be furnished with an account showing how much of the charges of the company for the carriage of his merchandise is for conveyance, and how much is for terminals, and what are the items of the terminal charges.

Notices must be put up at every station at which merchandise is received for conveyance, that the tables referred to are open for inspection, and that information as to charges can be had from the secretary.

There is to be a penalty not exceeding £5 *per diem* for each offence against the preceding provisions.

Agreements between Companies.

Canal companies may enter into arrangements with each other for the passage over their canals of through traffic, and for the use of each other's wharves, &c., upon payment of such through rates as may be agreed upon, and may in such agreements provide for the building of warehouses and offices, and may spend their funds on such buildings. Existing contracts to this effect are to be deemed valid.

Clearing House.

Power is also to be given to the companies to establish a clearing house, and to apply their funds to that object.

Railway Companies and Canals.

There are stringent provisions to the effect that no railway company, or director, or officer of a railway company, shall without express statutory authority apply, or use, or authorise, or permit the application, or use of any part of the company's funds for acquiring, directly or indirectly, any interest in a canal. Contravention of this is to involve a forfeiture of the acquired interest to the Crown, and to impose on the director or officer the penalty of having, at the instance of any shareholder, to repay to the railway company the money so applied or used.

Returns and Reports.

These are provisions requiring canal companies to make full statistical returns as to their canals. Every year each company is to send to the registrar of joint stock companies a return stating the name of the company, a short description of their canal, and the name of their principal office and officer.

They will also be required to send in, not oftener than once a year, in such form and manner as the Board of Trade may from time to time prescribe, such returns as the Board may require for the purpose of showing the capacity of such canal for traffic, and the

capital, revenue, expenditure, and profits of the company.

Whenever a canal or any part is intended to be stopped for more than two days, the company will have to report the fact to the Board of Trade, stating the time during which such stoppage is intended to last. When the canal has been stopped the re-opening must also be reported.

Penalties are imposed, not exceeded £5 *per diem*, on companies and their officers for breaches of these provisions as to returns and reports.

Bye-laws.

Every canal company will have to furnish copies of their bye-laws and regulations to the Board of Trade. Failure to furnish these will have the effect of annulling the bye-laws. No new bye-laws can come into force until they have been two months in the hands of the Board of Trade, or have been allowed by the Board. Existing or proposed new bye-laws may be disallowed by the Board.

Inspection.

Whenever the Board of Trade are informed that a canal is in such a condition as to be dangerous to the public, or to cause serious hindrance to traffic, they may direct an inspection and report, and the inspector is to have all the powers that are now possessed by inspectors of railways.

Abandonment.

There are provisions for the abandonment of canals, and for enabling the Board of Trade, if they think that a canal which is to be abandoned, should be transferred to any other body, to make a scheme for its future management, and for the establishment of a body for that purpose, and to limit the liabilities which may affect the owners of the canal.

INLAND TRANSIT—A NEW DEPARTURE.

By W. Martin Wood.

Many circumstances suggest that this United Kingdom is, or ought to be, at the point of a new departure in the matter of inland transport of bulky materials and heavy manufactures. It is chiefly in respect of these commodities, of which our coal and iron deposits and the energy of our people expended thereon are mainly the bases, that our general commercial supremacy has been maintained. That supremacy is threatened; and it is of little use saying to each other "Who's afraid," for the history of commerce shows that when once a leading position is really lost, an unequal struggle sets in, which, unless faced and grappled with as soon as recognised, may rapidly tend towards accumulating loss, and ultimate decadence. Therefore, one of the most obviously needed objects at the present time is that of dealing with our heavy and bulky internal traffic at a much lower cost than now obtains. That object has been fairly attained in respect of our ocean transport, which, if not exhibiting so great supremacy as formerly, still maintains for this country a great relative superiority. Similar principles applied to our inland traffic will secure similar results; but those principles must be applied as speedily as the nature of the case permits, and with strong national determination. Though the man in possession—chiefly the gigantic railway confederation—may protest, class interests must yield to the supreme claim of aggregate national industry, and the broad interests of the commonwealth.

1. It has been said that the methods and objects of civil engineering can be simply and comprehensively expressed in the brief phrase —"removal of friction." It was, at the time, a valuable effort in this direction when the now almost forgotten Macadam enriched the language with a new word, and enriched the country most emphatically by originating the appliance of metalled roads. But a vastly greater stride was taken in the removal of friction when George Stephenson and his successors placed on those roads lines of metal suited to the metalled tyres of wheeled carriages propelled by steam-engines travelling on the same smooth surfaces. Of this method of inland transport Englishmen may well be proud of being the pioneers; and they may fairly claim to have brought this method to perfection in any reasonable sense of that word. But do not let us be blind to its inevitable limitations—which we chiefly express in the terms of cost. And this again consists mainly in the expense of propelling and sustaining the load, which expense in both respects increases rapidly in proportion to speed. The encumbrance of non-remunerative dead-weight is also inseparable from transport by railway. Thus, the problem of the day being to carry our heavy and bulky traffic at a minimum of cost, we shall do wel

to fall back on another maxim, as old as the rivers—" put your burden on the water when you can." By this means you reduce friction to its lowest form, while the bulk and weight of your traffic can be increased in greater proportion than cost of moving it. Here it may be well to premise there is no expectation anywhere that canals can supersede railways. What is contended for is that waterways shall be restored or expanded in order to serve that description of our inland traffic which railways have failed adequately to cope with, or cannot at such low cost as is demanded by the inexorable exigencies of modern competition. There is no question of returning to the antiquated though picturesque system of horses and towing-paths. No! the organisation of inland navigation required by our modern industrial conditions demands and must evoke the best results that mechanical engineering can effect by means of Steam and Steel.

2. Papers comprising specific comparisons expressed in technical terms, showing the difference of cost of transport by waterways and ironways respectively, have been or will be placed before this Conference by professional men; so it is not desirable for me to do more under this head than state a few general comparisons. In the comprehensive work of Mr. R. Webster, the immensely cheaper system as compared with railways is conclusively vindicated. Take, for instance, the Aire and Calder Canal, on which, as he points out, merchandise has been carried by steam-tug locomotion at the rate of $\frac{1}{34}$d. per ton per mile. The average railway freight for coal is probably understated at $\frac{1}{2}$d. per ton per mile, or 17 times the cost of transit on the Calder Canal. Even with the old-fashioned horse-power the water transit may be taken at $\frac{1}{5}$d. per ton per mile. Let that 1 d cost. by canal as compared with rail be applied to the enormous mineral and other heavy traffic of this country; then let reference be made to the much larger proportionate canal mileage already in use in France and Belgium, and we must recognise at once one of the obvious causes of depression in the heavier manufactures of the country. Only recently in the case of a large contract for steel rails it is said that 2s. 6d. was the dividing line as between Sheffield and Belgium. Had the former possessed adequate water transit to the Humber, Sheffield could and would have obtained the transaction; but the extra 2s. 6d. took the whole business to Belgium. There are probably several men here who can cite similar instances of British trade being thus handicapped by our neglect to keep pace with modern requirements in providing waterways suited to the large commerce of modern times. Take the Firth and Clyde Canal, which in spite of its imperfections carries at about $\frac{1}{7}$d. per ton per mile. Those who have followed the remarkable progress of Lanarkshire and the western capital of Scotland during the last forty years—of which the Glasgow Exhibition, opened this week, is such a splendid commemoration—must admit that much of that progress is due to the local facilities of water transit, imperfect though that canal system is compared with modern requirements.

But, in order to form a just conception of the great reform in our internal traffic that would be gained by water-carriage, we claim to disregard the disjointed, old-fashioned, and railway-ridden canal system (if such it can be called) now existing. The case must rest on the facilities that would be afforded by a properly-organised modern system of internal transit on waterways worthy of the name. Here I may be permitted to quote a sketch of one main line of such system, at once concise and comprehensive, supplied to me some months ago by an eminent, but now retired and aged engineer:—" What would be the effect of a steam-boat canal from London to Liverpool (put it from the Mersey, or the Manchester Ship Canal, to the Thames, if you like), carrying at all speeds, from five to thirty miles per hour, at a cost of a farthing to a halfpenny per mile for passengers, and of one-tenth of a penny per ton for goods, conveying, probably, five or six million tons a year, the boats loading and discharging at every point on either side, men of property having their own private boats, to start whenever they pleased, carrying on their business on the way. At present, nobody can conceive what the effect of such a highway would be. It would save the city of London alone several millions a year, in cost of carriage."

Or, to put it the other way, venturing on an estimate of cost, but proceeding on the necessary assumption—soon we trust to come within the range of practical projects—that the estraneous obstruction of monopolising railway companies shall be superseded by the people's right of way being restored, the much mixed canals now existing being purchased, or otherwise resumed by the State. The course being thus cleared, an arterial waterway from Liverpool (or Warrington on the Ship Canal) to

London might be constructed at, say, £15,000 per mile. This outlay, involving a fixed charge for interest at 3 per cent., and 1 per cent. for direction and control, would require a net return of £600 per mile per annum. This income would be provided for by a traffic charge of $\frac{1}{30}$d. per ton per mile, and $\frac{1}{20}$d. for cost of draught, the whole rate of toll being $\frac{1}{12}$d. per ton per mile. This is, of course, on the condition that all modern facilities would be afforded by steel for vessels, and by the latest improvements in marine engines.

To illustrate the comparison between cost of transit by ironways and waterways over long distances, let me cite one stated by a distinguished railway engineer, Sir Bradford Leslie. It is indicative of his impartiality that the comparison is as against the railway of which he was part constructor and long time chief engineer and manager; that is, the Eastern Bengal. He thus put before the merchants of Calcutta his estimates of canal traffic, returns, and cost:—

"With respect to revenues, when a canal of sufficient capacity is once available there is no doubt it will command the whole of the goods traffic, provided the tolls are not too high. The Eastern traffic is 1,900,000 tons per annum, and it is rapidly increasing. A toll of 2s. 6d. (*i.e.*, one farthing per mile) on this traffic alone would yield a return of £237,000, sufficient to pay all the expenses of working and maintenance, and yield a return of 11 per cent. on a capital of two millions. Another engineer considers this estimate of cost unduly high. For three or four months in the year the western traffic finds its way down the Nuddea River; but in the dry season, when this is unnavigable, it would go *viâ* the canal, and this traffic would probably double the receipts. I think it would therefore be sufficient to apply for power to levy a maximum toll of 2s. 6d. a ton. Assuming the actual cost of transport to be 1s. per ton, the total cost of goods would be 3s. 6d., at which rate there would be a saving of £840,000 a year on the Eastern traffic alone, as compared with the present cost by rail, boat, and steamer."

Such canal from the Hugli to the junction of the Ganges and Bramaputra, at Goalundo, would be something less than two hundred miles. To take a more familiar route, that from the capital of our Midlands to the East Coast. As recently pointed out by a competent writer in the *Daily News*, a canal to connect Birmingham with the Trent Navigation channel, which would only be about 170 miles, would take capacious barges that distance in less than the twenty-four hours, which would be ample speed for the heavy trade to be served. That writer calculates the cost of carriage for that distance at 8s. per ton — quite a high estimate, but very small compared with cost by railway for similar distance. The same writer estimates the charges on an improved steam-worked canal, from Warrington to London, at 6s. per ton. This is far higher than the estimate already given, but as the present railway charge is about 17s. 6d., there is a wide enough margin on which to work off the encumbrance of our present heavy traffic. Again, it must be remarked that there is no desire to supersede railway service, nor to disparage its value for its proper purposes. But it has long been plain that railways cannot keep pace with the expansion of the larger and heavier portion of our modern industries; while in the vain attempt to perform that task our lines are overburdened in their proper duty of serving the passenger, mail, and other light traffic.

3. England cannot afford to neglect the large accession to her industrial energies which would be gained by a complete and modern system of inland navigation. If we refuse to learn from our own necessities, continental nations will compel us to take the new departure. There are large stores of coal in Germany, and preparations are being made to utilise those land-locked resources of that empire by a system of canals, which will enable that coal to be used in western districts for manufactures. These will compete with renewed keenness for trade that our looms, forges, and workshops now supply. The International Congress on Inland Navigation, held under Imperial auspices at Vienna, two years ago, is a significant sign of the times that has not received due attention in this country.

France has taken up the lead in canals of navigation which we lost 60 years ago. That country has spent £40,000,000 sterling on canals, and is still bent on extending inland navigation as rapidly as the crushing weight of her enormous military expenditure will permit. And it is not only internal navigation that the canal engineers of France concern themselves with. At a recent meeting of the French Association for the Advancement of Science, held at Toulouse, the project, long entertained, for a ship canal from Bordeaux to Narbonne, thereby to unite the northern

Atlantic and Mediterranean, was carefully revised. The length of the canal would be about 330 miles, at a cost now estimated of £26,000,000. The immediate object of this grand work is to save French commerce of the western coast the detour of 680 miles in its traffic with the northern Mediterranean ports and all the western coast of Italy. But such ship canal would also serve British commerce, though subject to profit that would be drawn by French proprietors and the State.

4. It is impossible that we should stand still in face of legitimate competition of this kind, consisting only in utilising the agency of water carriage, which is the most effective method of distributing the enormous commerce of modern time. But there is one condition precedent that is essential to the carrying out of this great reform in our system of internal transport—that is, the waterways of the country must be in impartial, that is, non-commercial hands. Of our present 3,000 miles of canals, 1,436 are owned by railway companies. The question of acquisition and control of our railways by the State is still debateable; but costly experience has shown that such through routes of waterways as those we are advocating must not be subjected to proprietary profit-making; they must be maintained and controlled for the equal benefit of all our commercial and manufacturing interests. This need not result in fresh centralisation. The canals of France are mainly created by the co-operation of the State, and the localities immediately served, and are treated as a great public interest. The late Charles Waring's masterly plea for the control of railways by the State applies with far greater force to such a thorough system of inland navigation, towards which it may reasonably be hoped this Conference will prove to be an important step. In a summary of Mr. Waring's proposals, which I take from an evening paper, let me substitute "canals" and "waterways" for railways, and thus serve to concisely state the argument:—"The question is, whether the canals are to live upon the industries, or whether they shall be used to co-operate in supporting those industries. It was Mr. Waring's aim to show that if, in place of dozens of amateur boards, scattered all over Great Britain, and mobs of brokers, jobbers, and commission men, who all live by their dexterity in snatching the profit (to be) made by the waterways out of the industries of the nation—if, instead of this extensive system of middle-men, the waterways of the country were under the control, as in Prussia, France, and Belgium, of a State department, and if limited liability shares were replaced by an issue of consols, our industries would be stimulated by low, uniform rates; and even agriculture, at present so hopelessly depressed, might be expected to revive."

It is manifest that this great agency of national industry ought to be relieved from the incubus of expensive Parliamentary contests at the outset; so that the first cost shall not be over-weighted by thriftless outlay on conflicts of private and proprietary interests, which are so much deducted from the service that these public works are destined to render to the nation as a whole. The Manchester Ship Canal has been thus burdened with a waste due to our present bungling strife of private interests, of at least £150,000—£4,500 per annum. Every ton of goods that traverses the canal will have to bear its share of that superfluous burden. The President of the Board of Trade has averred that the acquisition of the existing canals by the State is a practical question calling for serious thought and early attention. The way is thus cleared for the next great step forward, that is for State control of the present and future waterways, and the organisation of a complete system of waterways throughout the island of Great Britain. The principle is already admitted with regard to Ireland, but how narrow are the views that prevail on this subject may be illustrated from the report of last year's Royal Commission on Irish Public Works. The main object of the Commission, as set out in its patent of appointment, was to inquire what could be done to provide more harbour accommodation on the western coast, and to ascertain what measures are required for the improvement and preservation of facilities for inland navigation. Seeing that a great railway man was placed at the head of this Commission, there may be little cause for surprise that the Commissioners arrived at the *reductio ad absurdum* of recommending the shallowing of the Shannon, Barrow, and Bann, and for curtailing the poor inland navigation that already existed. Verily it is high time that the New Departure were taken on this vital question of national public works.

Mr. E. J. Lloyd said he wished to correct a common mistake with regard to the continental canals being on a level. It was perfectly true that most of the Dutch canals were level or nearly so, but with regard to the Rhine and Marne Canal, it

attained a height not approached by any in England; the summit being 1,234 feet above the level of the sea. A speaker had referred to chain traction, and he might say that that was employed on the Seine, and one or two other canals in France, but the best traction was on the Rhine, where wire-rope was employed, and it was marvellous to see the enormous weight which could be hauled, and the accuracy with which the rope could be re-laid in going round an extremely sharp bend in the river. His own feeling, before seeing it, was that the great difficulty would be in re-laying the rope in the deep channel, and that in passing round sharp bends it would be re-laid in such proximity to the shore as to prevent it being followed by the succeeding craft, but that was not so. With the great experience gained, they were able to lay the wire-rope all the way up the river in the deep channel with extreme accuracy, and he believed the cost of transport there had been reduced to a point of which we had no experience in England.

The CHAIRMAN then invited discussion on the preceding papers. He said Mr. Marten's papers were very interesting, especially as they were so eminently practical. Mr. Lloyd's paper had been more retrospective, but his proposal to join the four great rivers by a canal 70 feet wide was a great undertaking compared with the more moderate proposal of Mr. Marten.

Mr. J. T. BRUNNER, M.P., said Mr. Saner had given a very interesting paper, but he had some fault to find with the concluding paragraph. He said the income of the trust was £60,000 a year, and the surplus now handed over for the benefit of the county rate was some £15,000. That statement elicited some little applause in the room, but he wished to bring to the attention of the meeting that this £15,000 a year, being the surplus, after providing for interest on capital, &c., was simply a tax on trade, and he appealed to the Conference to give their sympathy to the salt trade, which was thus being taxed for the benefit of the community. During the existence of the trust, since 1720, the salt trade in Cheshire had contributed to the relief of the county rate over £2,000,000 sterling. At one time that trade was an exceedingly prosperous one, and bore that tax without inconvenience, but now it was sadly depressed, and had to meet competition in various parts of the country. Near Middlesbrough, at the mouth of the Tees, a large source of salt supply had recently been developed, and 200,000 tons of salt were annually made there. The price had fallen to 3s. 6d. a ton for common salt in consequence. The surplus spoken of was some 25 per cent. on the gross income, so that the toll on salt was rather more than 25 per cent. too high. Threepence a ton, which was 25 per cent. on the 1s. toll, was a serious tax on an article only worth some 3s. to 3s. 6d. In 1866, a further tax was imposed on Cheshire in the cattle plague rate, in spite of all the protests of the people, the excuse for refusing to make the rate national being that Cheshire had this surplus from the Weaver. Now, in 1896, this cattle plague rate would come to an end, and it amounted to £14,200 a-year. If when this ceased the country also ceased to receive £15,000 surplus tolls, no ratepayer in Cheshire would feel one penny the worse, and his desire was that this tax on trade should come to an end at least in 1896, and he trusted the Conference would aid in effecting this object. The trustees were county gentlemen almost without exception, some few being appointed as representatives of the towns. Being county gentlemen they had as a matter of course conducted their work honestly. He should be very glad if anything he had said would induce the Conference to aid in freeing the trade from an intolerable tax.

Mr. J. H. TAUNTON said there was one statement in the interesting paper describing the foreign canals which involved an engineering inaccuracy, and which he thought should be corrected. It was stated that lock water was saved by large boats entering the lock, whereas the fact was that whether the boat was large or small the same quantity of water would be required. With regard to Mr. Marten's interesting paper, he should like to know the cost of haulage on the River Severn. The trains of boats were admirably arranged there, and he might be able to say whether they had practically the same rates as on the Gloucester and Berkeley Canal. Mr. Clegram had given the cost of haulage on that canal as $\frac{1}{13}$d. per ton per mile, whilst in another paper Mr. Thomas had had given the cost of haulage on the Grand Junction Canal by steam at $\frac{1}{6}$d. per ton per mile.

Mr. DUMBLEBY said there was one important point with regard to the canalisation of the River Severn which had not been alluded to, and that was the existence of a coal-field in Shropshire, which Professor Molyneux had stated to be eighteen miles long by seven wide, at the present time. It had been tapped and proved, but was practically useless for want of means of communication. The only means at present was the Great Western Railway, which ran a single line called the Severn Valley line. If ever the Severn was canalised beyond Stourport, as far as Bridgenorth, the coal of that region would be available for the general market, and, in fact, this field was the nearest to London of any, and it would be an immense benefit, not only to the metropolis, but to that part of South Staffordshire district which was contiguous to it.

Mr. EDWARD HAYES said he had listened with great interest to Mr. Marten's paper, but there was one point he should like mentioned. Mr. Marten suggested the width of the canal should be 45 feet at the top, 21 feet at the bottom, with a depth of 8 feet. Now having had twenty-five or thirty years' experience of

canals, he had become fully convinced that the width of a canal should be at least nine times the beam of the vessels working upon it, and the depth should be twice the draught. [*Note by Mr. Hayes*:—Taking Mr. Marten's suggested width of 7 feet for boats of the highest speed which gives on surface of water 63 feet width, the depth should be 7 feet, the sides 18 inches or 2 feet deep from the surface of the water, angled off at about 45° to the bottom depth. Mr. Hayes entirely agrees in Mr. Marten's view as to the width of locks, more especially on the Grand Junction Canal. The proportions given do not apply to the barges or slow boats, which should be 14 feet beam, and vary in draught with advantage. Each type of vessel should be limited to a certain speed. The fly boats on such a canal should not exceed 3 ft. 6 in. in draught; the tugs, however, may have a draught of 4 ft. 6 in., in order to give immersion to the propeller, and the medium-speed vessels a draught of 4 ft. to 4 ft. 3 in. Each lock, in Mr. Hayes's opinion, should admit only two boats 71 feet long by 7 feet beam each.]

Mr. MARTEN said he had some information as to the cost of steam haulage on the Severn, but it was from private sources, and as its publication might affect the interests of the private carrying firm who conducted the steam towing business at the Severn, he did not feel at liberty to say more at present than that the cost was exceedingly moderate. He quite agreed with what had been said about canalising the Severn up to the Shropshire coal-fields; and he might say that plans, sections, and estimates had been prepared for that purpose, which showed that the work could be accomplished for an outlay of about £210,000, not a very large sum for so great an object. There seemed, however, at present to be a certain amount of apathy in Shropshire with respect to the question, but everything was ready to enable the work to be proceeded with, the moment there was further encouragement or new coal-fields were opened. With regard to the question of width on a canal, it was no doubt advisable to have a canal as wide as possible. It made a great difference in the travelling speed of a steamer or tug-train whether the width were small or large, as, other things being equal, the larger the area for the "go-by" of the water displaced by the passing vessel or train of boats the greater the speed. In his paper on "The Improvement of the Water Communication between London and Birmingham," he had proposed that the minimum top width of the improved canal should be 45 feet; the average top width would be 56 feet, and on the towing-path side it was intended to construct a wall extending to a depth of 3 feet below top water line. A wall of this description was practically equivalent to extending the top width, as it greatly facilitated the "go-by." In order to widen the canal to the moderate extent he had proposed, it would be necessary to purchase something like 360 acres of very valuable land—at least, it would be so described when they came to purchase it. If the width of the canal were to be doubled, the additional quantity of land required would be very large—as there would not only be a strip of land 50 feet wide and 146 miles in length to be purchased—which alone would approach 1,000 acres—but it would also be necessary to provide a very large area for the deposit of spoil derived from excavating the canal to the increased width. Further to this would also have to be added the cost of excavation, increased width of bridges, and other such incidentals. So that, although at the first blush it appeared a very simple matter to suggest that the proposed canal should be 100 feet in width, yet when considered from an economic point of view—and all these matters had to be, and had been, considered in that light—it was found that they would have to content themselves with the modest but less costly proposals named in his paper. In reply to another question, he said the cost of steam haulage on the proposed canal would, on the average, be one-sixth of a penny per ton per mile, or 1s. 10d. per ton from London to Birmingham. With regard to swing-bridges, Mr. Moens stated there were several on foreign canals which opened in two or three minutes. This was a longer time than was generally found to be necessary in England. In fact, there was one on the Severn, of 45 feet span, which was opened in 59 seconds.

Mr. E. J. LLOYD said he represented 40 miles of this canal proposed to be made from Birmingham, coming south. He had estimated the value of the land in the possession of the canal company within 10 miles of Birmingham, four miles being within the borough, and the value of the land and other property, without any compensation for severance whatever, was more than the capital of the company, so that if the width of the navigation were largely increased beyond the point fixed by Mr. Marten, it would largely increase the capital cost in land alone.

Mr. EDWARD HAYES said the width of the canal was an important point, as he had found from experience extending over many years. He was convinced that it was impossible to work a narrow canal satisfactorily, and he thought if they were to have canals at all they had much better have good ones.

The CHAIRMAN then proposed a cordial vote of thanks to the readers of the papers, which was carried unanimously.

Mr. H. TRUEMAN WOOD, the Secretary, said he had been requested to announce that the International Conference on Canals and Inland Navigation would be held at Frankfort, in August next, and the programme would be ready in a few days, but any particulars could be obtained from Mr. Bateman, 18, Abingdon-street, Westminster.

Mr. J. J. Colman, M.P., then proposed a vote of thanks to Sir Douglas Galton, and to the Society of Arts, for initiating this Conference, which he ventured to think would prove as useful as any which had been held in that room.

Mr. Hyde Clarke seconded the motion, which was carried unanimously.

The following papers were received after the closing of the Conference:—

RELATIVE COST OF TRANSPORT BY RAILWAY AND CANAL.

By W. Shelford.

The figures given by the various writers and speakers at the Canal Conference, on the relative cost of railway and canal transport, differed very widely. Mr. Lester stated in his paper that the cost on railways had been estimated at 2d. per ton per mile, and Mr. Adamson said that freight could be carried by water at 1-100th of the rate by rail.

If canals are to be made on such figures as these and others which were quoted, there may well be a feeling in favour of a Royal Commission to investigate the whole subject, before incurring any large expenditure, or inviting the Government to purchase the canals.

The traditional independence of Englishmen is opposed to Government interference, and yet the descendants of Englishmen in Canada and the United States are now enjoying the benefits of artificial waterways provided by their Governments. It is worth while to inquire as to their experience, the more so because the Americans have had to study the question most fully, in order to compete with India in the supply of wheat to the English market.

The Department of Agriculture of the United States has given figures which throw great light on the relative economy of railways and canals—figures which have no analogy in the statistics of this country.

The circumstances are these:—

Half the exports of wheat are from districts whose nearest point is 1,400 miles from the Atlantic sea board. This wheat is carried by water and rail, which are in independent hands, and form alternative routes.

Let us take for comparison the routes between Chicago and New York:—

Rail	912 to 990	say	950 miles
Water	Lakes	985	
	River and Canal	420—1,405	,,

that is, the water route is 50 per cent. longer than the railway.

Yet the water route rules the rate, because the water transport costs $\frac{1}{8}$d. per ton per mile, while the railway transport costs nearly $\frac{1}{5}$d per ton per mile, and the total rate by water between Chicago and New York is two-thirds of the rate by rail.

So far, there is a *primâ facie* case in favour of canals.

But if the cost of transport by water be taken separately for the lakes and Erie Canal, it appears that the cost on the lakes is $\frac{1}{12}$d. per ton per mile, and the cost on the Erie Canal and Hudson River is $\frac{1}{6}$d. per ton per mile, so that the cost of transport on the Erie Canal is double that on the lakes, and is nearly the same as the transport by railway.

(I have eliminated from the cost of railway transport the interest on capital and maintenance of way, so as to make a fair comparison with the cost of transport on the Erie Canal, which the State of New York maintains as a free highway, securing thereby the position of New York as the principal port of the United States.)

It is, therefore, not surprising that the first report of the Interstate Commerce Commission of the United States, published in December last, states that "the experience of the country has demonstrated that the artificial waterways cannot be successful competitors with the railways on equal terms."

This report is a masterly production, and should be read by all who are interested in the question of transport. It has been republished in this country as a Parliamentary Blue-book, and may be bought through any bookseller for 4½d.

The experience also on the Continent appears to confirm that of America, $\frac{1}{6}$d. per ton per mile having been obtained by M. Gobert, the well-known canal engineer of Belgium, in his estimates of the cost of transport on canals.

No doubt this $\frac{1}{6}$d. per ton-mile varies, and may be reduced, to some extent, by improvements, and especially by such as would result in economising time, so as to make the through speed in canals more nearly approach that on open waters. The cost of transport also depends somewhat on the country traversed. In England, with its complicated conditions of traffic, it is not safe to draw general conclusions, but each case that arises must be considered by itself. American experience however, which is wonderfully like ours, points to the great importance of the acquisition and maintenance of our canals at the public expense.

THE CANALS AND SHALLOW-DRAFT STEAM NAVIGATION OF CANADA.

By C. C. S. Drummond.

The inland canal and lake system of Canada, together with the United States Canal, at the Sault St. Marie, has formed an unbroken water communication, for vessels up to 1,800 and 2,000 tons (gross), from Duluth, at the western extremity of Lake Superior, to the Straits of Belle Isle, at the mouth of the St. Lawrence river—a distance of 2,384 miles. And it may be worth while to mention, as touching the usefulness of these great works, that last year a larger tonnage—and, of course, many more bottoms—passed through the Sault St. Marie Canal, to and from Lake Superior, than through the Suez Canal, during the same period.

The difference in level between Lake Superior, and the St. Lawrence, at Montreal, is about 600 feet, and 55 locks are required to overcome this, although the mileage of the eight canals is but 71. The ordinary locks of the Canadian canals are 270 feet long, by 45 feet broad, and 14 feet on the sills, and the American locks at the Sault, 515 feet long, 80 feet wide, and 18 feet on the sills. These locks are all built specially wide, to accommodate the various classes of steamers and barges employed, for, although in England the trade is built to suit the boats—in America, the boats must be built to suit the trade, and the locks accordingly.

Without going into the details of the various kinds of steamers employed and their dimensions, permit me to say, that from the great floating palaces of Long Island Sound, between 500 and 550 feet long and 90 feet beam and accommodating a thousand or more passengers in the greatest comfort, to the little ferries of the Thousand Islands, there is a long list of vessels, as distinct in build and design, as are the uses to which they are adapted.

It is not my intention to put before you this list, nor even refer to more than one of the classes, viz., the shallow draft steamers and barges, although it will give me pleasure at some future time to afford you any information you may desire.

The "river steamer," as the stern-wheel shallow draft vessels are called, is a boat of peculiar construction. Three things are absolutely necessary. First, a perfectly smooth bottom; second, an absence of rigidity in the hull and motive-power; third, a propelling-power on the surface of the water-Three points apparently of easy accom. plishment, but in reality very difficult, and which to understand requires long practice with the steamers, and their uses. Indeed, no inconsiderable portion of a captain or pilot's life has passed before he has learned the "handling," but when once the lesson has been learned it is wonderful what can be done with these wheelbarrow steamers.

In my experience I find them by far the most useful class of boats we have. The absence of a keel, or any such obstruction enables the boat to be turned like a dish on the water; while the four rudders (sometimes 20 feet long) will guide her with a nicety in rapids and currents where an ordinary steamer would be helpless. The absence of rigidity in the hull and machinery enables the steamer to be driven ashore on any soft bank, the cargo discharged or loaded, and the boat without difficulty backed off.

The propelling power is a large diameter wheel at the stern of the boat, the full width of the vessel, and resembling the undershot wheel of a mill, and driven by two cylinders, one on either side. The floats of this wheel are but eight to ten inches in the water when light, and say thirty inches when loaded, and do not therefore produce those destructive currents which come from the screw or paddle steamer.

I am therefore of the opinion (formed after years of observation) that an adaptation of the stern-wheel smooth-bottom steamer is the best for cheap canal navigation.

The boats which we use on the rivers of the north-west of Canada are about 220 feet long, 38 to 40 feet beam, and 10 to 12 inches draught when light, and carry themselves about 400 tons, and will push (not tow) three times as much more on barges built like the steamers.

WATER TRANSPORT.

The resolution passed on the 11th inst. marks decided progress in public opinion as to waterways. Sixteen years ago anyone advocating water transport was promptly accused of galvanising a corpse, but now the prevalent ideas seem to be that salvation for our trade can only be found in canals, and that hydraulic lifts are to raise us out of our difficulties.

Gradually, perhaps, we shall begin to see that canals are but the smallest links in a water-system; that the question broadly is one of cheap transport; and that if we are to succeed, as other nations have done, we must follow their lead. Not being an Englishman, nor an admirer of English methods, I fail to see the advantage of our public routes having

to bear the burdens of past strifes or of adding future and larger ones. Mr. Martin Wood has pointed out the result of this, in the case of the Manchester Ship Canal.

The Conference having met in the South-East quarter of Great Britain, seems to have consisted mainly of members from that locality, who would naturally be to some extent effected by their surroundings; and this may account for the rejection of General Rundall's proposal, which I virtually seconded.

In *re* cheap transport, the *rôle* of the State claims consideration. It may—

1. Make, maintain, and work national routes.
2. Make, maintain, and administer the routes, but leave the working to companies or individuals.
3. Offer contributions proportional to what localities give.
4. Give loans or concessions to constructing localities or companies.
5. Give loans for termini or stations (as in the case of our coasting-trade).
6. Remain quite inert.

Comparisons with Continental precedents can have little weight, unless these six alternatives are carefully distinguished. The difference between the national rate of interest on the one hand, and of commercial or local rates on the other, may represent the possibility of amortisation which has been so little provided for in the case of our public routes, but which is such an important element in national economics.

The purchase of our present canals by the State might, in flat districts, check the charges of railways, but would leave them to recoup themselves on higher levels. East Anglia, for instance, might be made a second Holland, but there would remain many wealthy districts remote from waterways. On every estuary there must be a point where the sea-going craft may most advantageously transfer her cargo to the inland-going steamer, and opinions as to the most favourable places for such transfers may well be sought from impartial and competent minds. In the case of the Severn, for instance, would Gloucester, Sharpness, Sheperdine, or other point, be the most suitable? And again, would such point, when chosen, serve also as the western outlet for Thames basin traffic?

The question of transport is, however, inseparable from collateral subjects. As a drainer of land, and a cheap carrier of refuse, a canal is often a potent bringer of wealth and health. In the case of the new Rhine-Ems Canal, and of the networks of Groningen and Drenthe, such considerations have had much weight. In the Dutch veens, the fuel, so bulky in proportion to its value, plays an important part, as in the poorer parts of our Union; but the recent report of the Royal Commission on Irish Rivers will, it may be feared, strengthen the idea that such things are judged by minds imbued rather with the rolling-mills of Great Britain than with the natural capabilities of Ireland.

Steam and steel, by enabling us to cope with floods and ice, have greatly modified Brindley's dictum about rivers. Those in these islands, though mostly puny and winding, are capable of much work in their straighter parts. The Severn, between Gloucester and Worcester, in the hands of Conservators, charges only ·2d. per ton mile for tollage (see Mr. H. J. Marten's paper), and furnishes a convenient standard with which charges, actual and potential, on other rivers (natural and artificial) may be compared. Unfortunately, the water outlet to the Bristol Channel is in commercial hands. Despite the advantages of steam, frequenters of towing-paths will have remarked, that the old pattern craft still seem to hold their own side by side with the new power; and even in the coal districts of Belgium one sees few steamers.

The advantage of Mr. Bartholomew's system in saving steering labour seems to have been little dwelt on. The late Sir B. Frere's suggestion, that the State should seek to afford *bona scientio* appears applicable to such a proposal as Mr. Conder's, for a semi-elliptical canal, of which, however, I have as yet found no instance, even in recent projects. The expression of the former witness that new waterways would "court a fall," may perhaps be taken rather to mean that they would court a flat; and as, in doing so, they might resort to bold engineering, making free incisions and drying neighbouring wells, this would bring in subterranean water-questions.

The movement of our industrial population towards deep water may not be unwelcome to sanitarians and riparians, but if it is to be checked, the movement with that object must be initiated in a national spirit, and should be above any suspicion of "bulling" canals. If expropriation, to which railways owe their origin, is to be applied to them in their turn, anything that tends to enlighten potential jurymen may do eventual good, and may reconcile the eager opponents of a Royal Commission to a little delay, during which facts, figures, and ideas may take shape, though it is to be hoped no more waterways will be allowed to become commercialised.

WALTER M. T. CAMPBELL.

Edinburgh, N.B., 24th May, 1888.

Miscellaneous.

TOBACCO CULTIVATION IN THE DUTCH EAST INDIES.

The *Bulletin du Musée Commercial*, in an article upon the tobacco cultivation in the Dutch East Indies, says that the plant is cultivated in two different manners, according to whether it is intended for exportation or for local consumption. The home consumer prefers the long stalk leaf, and cares very little for the ground in which it is grown. When a plot of groun[illegible] chosen either in or out of the *desà* or village, it is sown [illegible] [illegible]ds have been pulled

up, and without being even dug up. If there does not happen to be sufficient natural shade for the young plants, they are covered with cocoa leaves. The end of the rainy season is the time usually chosen for sowing. In the morning or afternoon, seed mixed with sand or ashes is spread over the ground; it is then watered and covered with straw, in order to prevent the rains washing the seed away, and to keep the ground fresh in the middle of the day. The seed commences to sprout at the end of fifteen or twenty days, it is then necessary to guard against caterpillars, which have a preference for the shaded plants. At the end of fifty or sixty days, the planter for home consumption considers that the young plants are strong enough to transplant, and then commences to prepare the fields where the tobacco is to be cultivated. A preference is shown, as a rule, to the dry grounds, or *tégals*, as it is believed that tobacco cultivated in these is stronger than that grown in *sawahs*, or damp ground. Before taking the young plants from the nursery grounds they are well watered, and the strongest are first transplanted in rows about three feet apart. In this operation the farmer is assisted by his family, and it usually takes place in the afternoon. When the family is not large enough to assist in the work, friends and neighbours are called in to help him. A plantation seldom contains more than 3,000 plants. After planting, the young plants are again watered, and are protected from the rays of the sun by being covered with large leaves, chiefly those of the *djali*. During the dry weather they are watered every day until the plants have taken root, those which are weakly or dead are pulled up and are replaced by others, in addition the caterpillars are carefully removed. Occasionally the ground is weeded and broken up with a *patjol*, a species of mattock, great care being taken to heap up the soil around the stem. At the end of seventy days, the plants commence to bear buds; these are carefully removed with the fingers or with a small knife. After this operation, the shoots which spring from the stalk and injure the leaves are carefully watched. The highest leaf is considered by the growers as the best of the whole plant, and if it is desired to fully develop it the lower ones are sacrificed, so that in some cases only twelve or fifteen leaves are left on a plant, while those planters who only look to the quantity and not the quality of their crop only remove from eighteen to twenty of the leaves three months after planting, and when the leaves begin to have a yellowish-green tint the gathering of the crop is commenced. This is done leaf by leaf, and great care is taken to keep separate the higher leaves, the lower leaves, and these growing midway; or again, these are mixed together in a certain proportion, according to the exigencies of the market for which the planter is growing. The crop is covered with leaves of the pisang, *Musa paradisiaca*, and placed upon bamboo tables. After the lapse of twenty-four hours, or when the leaves have become completely yellow, they are removed from the stems, and the principal ribs are taken away; a dozen leaves are rolled up in such a manner as to leave the largest on the outside, and they are then cut up very fine. This is a fatiguing operation, and requires much practice. The tobacco known under the name of "shag"—in Dutch *Apenhaar*—which is sold in European markets, shows to what a degree of perfection the natives have attained in the art of cutting up. The table used for this operation is a simple plank, long rather than broad, furnished with two ledges widened towards the top. The rolls of tobacco are placed between these two ledges, and are pushed forward by the hand as the knife cuts off the layers. The knife used is composed of a very long and broad blade, in a short handle, and is used only for this purpose. When the planter's family is not sufficient for the cutting, friends and neighbours are called in to assist, and as a rule this assistance is not paid for in money, but the workpeople are well treated and receive a portion of the crop as their reward. For two or three days the tobacco which has been cut up is allowed to remain exposed to the sun, and during the night it is exposed to the air, as it is the opinion of the growers that the dew exercises a favourable effect upon the aroma and the colour of the tobacco. As soon as the tobacco is dry and of a brown colour, the layers are taken up and folded in two in the form of a square bundle. This operation is usually performed in the morning about nine o'clock, as then the tobacco is supposed to have got rid of the night dews, and has not become so dry as to be difficult to handle. The bundles so formed are wrapped up in banana leaves, and are then heaped up in bamboo baskets, covered in the inside with *pisang*, *djali*, and *alang-alang* leaves. In these baskets the tobacco is subject to a species of fermentation. When the tobacco is not intended for immediate consumption, it is kept in the baskets or in boxes, care being taken to exclude the air and light. The grower for the home market, who thus keeps his cut tobacco (*radjang*), provides himself with capital, for he knows that sooner or later, Chinese, Arabs, or the native merchants, will visit his village and purchase his surplus crop. Prices vary according to quality and circumstances, but native tobacco is always very choice, and assures to the grower considerable profit, if he is only careful to choose his time for selling. Prices generally range from 20 to 80 francs per picul, the picul being equivalent to about 137 lb. avordupois. Native tobacco from some parts of the Archipelago, for instance that grown in Paraan, Kadoe, Redjang, or Palembang, has a very high reputation, and fetches a high price. It is the usual custom of the Javanese to plant his tobacco in the *sawahs*, or watered lands, after the rice harvest, and in the *tégals*, or dry grounds, after the maize harvest. It is believed that the dry ground grows a stouter and more odoriferous leaf, and the irrigated lands a finer and larger leaf. The *Bulletin du Musée Commercial* states that the information respecting the tobacco industry in the Dutch East Indies has

been furnished by the Belgian Consul General at Batavia, who has also forwarded samples of the native products to the Commercial Museum, at Brussels.

Notes on Books.

THE TESTING OF MATERIALS OF CONSTRUCTION. A Text-book for the Engineering Laboratory, and a collection of the Results of Experiments. By William Cawthorne Unwin, F.R.S. London: Longmans, Green & Co.

The author points out how, under the pressure of modern necessities, the problem of using materials to the best advantage has come to be the first of all considerations in the mind of the designer, and hence a considerable advance has been made in the construction of all the apparatus used in testing, and the operations of testing are carried out with more care and skill. Abroad, great advance has been made in this subject, by the establishment of testing laboratories, supported by Government, in Berlin, Munich, and Vienna, and, more recently, at Watertown, in the United States. In this work, the author deals first with the mechanical properties of materials, and devotes a chapter to the consideration of stress-strain diagrams. Then the apparatus used in the engineering laboratory is described, chapters being devoted respectively to testing machines, shackles for holding testing-bars, measuring instruments, and autographic recording apparatus. The third part contains a collection of the results of testing of all the ordinary materials of construction—cast-iron, iron and steel, copper, copper alloys, timber, stone and brick, and limes and cements. The work is fully illustrated.

PROSPERITY OR PAUPERISM? PHYSICAL, INDUSTRIAL, AND TECHNICAL TRAINING. Edited by the Earl of Meath (Lord Brabazon). London: Longmans, Green & Co.

This volume contains a collection of essays on physical, industrial, and technical training, written by authorities on these subjects, and in some cases reprinted from various periodicals. Lord Meath contributes papers on the "Health and Physique of our City Populations," on "Physical Training," and on "Open Spaces;" Mr. Edwin Chadwick, on "The Half-time System;" Sir John Lubbock, on "Manual Instruction;" Mr. Samuel Smith, M.P., on "The Industrial Training of Destitute Children;" Sir Philip Magnus, on "Manual Training in School Education;" Mr. Cunynghame, on "Technical Education;" and Mr. Charles G. Leland, on "Industrial Art in Schools;" and besides these, there are many essays on cognate subjects.

A SHORT TEXT-BOOK OF INORGANIC CHEMISTRY, by Dr. Hermann Kolbe, translated and edited by T. S. Humpidge, Ph.D. Second edition revised. London: Longmans, Green & Co.

The author writes:—"The problem of the lecturer on chemistry is to give the masses an idea of chemical processes, and the most important chemical theories, without burdening their memories with a large number of mere facts, and thus prepare them to acquire an accurate knowledge of chemistry by their own practical work," and in producing this text-book he has adhered to this general principle. The editor has adapted the work for English students, so that the range covered is rather more than that required for the Intermediate Science and Preliminary Scientific (M.B.) Examinations of the London University. An appendix, containing an account of the methods used for determining atomic and molecular weights, of Prout's law, and of the Periodic Law, has been added by the editor. This second edition has been superintended by Mr. D. E. Jones.

SELL'S DICTIONARY OF THE WORLD'S PRESS AND ADVERTISERS' REFERENCE BOOK, 1888. By Henry Sell. London.

This is the eighth year's publication of Sell's Dictionary, which has now grown into a volume of 1,348 pages (including advertisements). Besides the lists of papers published in the British Isles, of magazines, annuals, &c., and of foreign and colonial papers, the work contains a series of articles on subjects connected with journalism and matters of journalistic interest.

General Notes.

CONGRESS OF PROVIDENT INSTITUTIONS.—The Right Hon. W. H. Smith, First Lord of the Treasury, and the Right Hon. H. C. E. Childers, M.P., late Chancellor of the Exchequer, have just been elected Honorary Presidents of the Permanent Universal Association of the Congress of Provident Institutions, in place of the Britannic Presidents deceased:—The Earl of Iddesleigh (Sir Stafford Northcote), and Sir Rowland Hill, who were among the founders of that scientific society, formed in Paris in 1873, at the suggestion of M. De Malarce. The other Britannic Presidents are his Grace the Duke of Rutland (Lord John Manners), Sir Lyon Playfair, M.P., Sir Charles W. Sikes, the promotor of the Post-office Savings Banks, and ten vice-presidents, men eminent in science and for social services. From a printed report received from New York, and dated 27th of April, to the General Honorary Secretary, M. De Malarce, by Mr. John T. Townsend, Senior President for the United States, it appears that the American Fellows of the Universal Society have already collected or prepared, in the divers States of the Union, the most reliable reports, on the popular institutions of savings banks, friendly societies, life insurances, building and co-operative associations, and the most comprehensive statements (historical, statistical, legislative, administrative notices, and others) that were ever got together on these subjects, documents destined for the universal archives of the Congress, for use next year, at the third quinquennial session of the Congress.

Journal of the Society of Arts.

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FRIDAY, JUNE 15, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-fourth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 27th June, at 4 p.m.

(By order of the Council)
H. Trueman Wood,
Secretary.

MEDALS.

The Council have awarded the Society's Silver Medal to the fellowing readers of papers during the Session 1887-8:—

To Prof. Silvanus P. Thompson, for his paper on "The Mercurial Air-pump."

To Walter Emden, for his paper on "Theatres and Fireproof Construction."

To Sir Philip Magnus, for his paper on "Commercial Education."

To Swire Smith, for his paper on "The Technical Education Bill."

To Sir Howard Grubb, F.R.S., for his paper on "Telescopes for Stellar Photography."

To R. E. B. Crompton, for his paper on "Electric Lighting from Central Stations."

To Henry Coppinger Beeton, Agent-General for British Columbia, for his paper on "British Columbia."

To James Rankin, M.P., for his paper on "Emigration."

To Mr. Justice Cunningham, for his paper on "The Public Health in India."

To Sir William W. Hunter, K.C.S.I., C.I.E., LL.D., for his paper on "The Religions of India."

To J. Starkie Gardner, for his paper on "The Monumental Uses of Bronze."

To Cecil Smith, for his paper on "Persian Textiles."

[A medal would also have been awarded to H. B. Wheatley for his paper on "Principles of Design, as applied to Bookbinding," had it not been that Mr. Wheatley is the secretary to the Section of Applied Art.]

CONVERSAZIONE.

The Society's *conversazione* will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, June 20th.

Promenade concerts will be given by the band of the Royal Artillery in the North Court, and by the Blue Hungarian Band in the East Architectural Court of the Museum.

A vocal and instrumental concert will be given by the Neapolitan Quartette in the Lecture Theatre, commencing at 9.15 o'clock.

A performance by the Royal Criterion Hand-Bell Ringers and Glee Singers will be given at intervals in the Casts Court, commencing at 9.15 p.m.

The Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the William Smith Collection of Water Colour Drawings, the Dyce and Foster Pictures, and the "Chantrey Bequest," will be open.

The courts and corridors of the ground floors will be open. The reception will be held at 8.30 o'clock, in the West Architectural Court, by Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Chairman, and the other Members of the Council.

As the accommodation for hats, coats, &c., is very limited, members will greatly promote the general convenience by not bringing with them more wraps than are absolutely necessary. A special building has been erected to serve as a cloak-room, but it is of necessity smaller than the court used in former years for the purpose.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer

prizes to art-workmen, in certain classes of art-workmanship, under the following conditions:—

1. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

(i.) Copies of existing works.

(ii.) Modifications of existing works.

(iii.) Original works.

It should always be stated under which heading (i.), (ii.), or (iii.), the objects are to be entered.

4. In awarding the prizes, the judges will take into account the following points:—1. Originality or beauty of design. 2. Fitness of treatment. 3. Excellence of workmanship.

5. Designs or working drawings will not be received in competition.

6. Before the award of prizes is finally made, the candidates must be prepared, if called upon, to satisfy the Council of their competency.

7. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

8. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for accident or damage of any kind.

9. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

10. All the prizes are open to male and female competitors on equal terms.

11. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

12. All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope, giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House or, if the necessary arrangements can be made, at the South Kensington Museum.

13. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges. Certificates will be given to the winners of prizes.

The following are the classes in which prizes are offered for the Session 1888-9:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5; second prize, £2.
   b. Shaved or turned, first prize, £5; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.
   c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for outside a window, a street-door panel, or for inside as a window screen, or for coil case, ventilator, &c.

Proceedings of the Society.

DR. MANN LECTURES.

PROTECTION OF BUILDINGS FROM LIGHTNING.

BY PROF. OLIVER J. LODGE, D.SC., F.R.S.

Lecture I.—Delivered March 10th, 1888.

One hundred and fifty years ago the nature of lightning was unknown. Several persons surmised that it had some connection with the phenomena excited in a piece of glass tube when rubbing it, phenomena which were called electric; but no proof of the connection was attempted. The proof that lightning was in fact nothing but a large electric spark was given, as you know, in 1751, by that marvellously comprehensive and commonsense genius, the Philadelphian printer, Benjamin Franklin.

This great man, a statesman of the first magnitude, might have made one of the first experimental philosophers, had he lived in quieter times instead of having to take a prominent part in the Declaration of Independence and in the great American War. A space of some twelve years limits his active devotion to electrical matters, but in that time he acquired a masterly grip of the subject, expressing himself very accurately and precisely concerning electrical theory, his statement of which is far superior to a great deal that has quite lately passed current in text-books; indeed, it is only now becoming capable of improvement through the labour and the inspiration of some of the still greater giants of our own day.

From the time that Franklin flew his kite at Philadelphia and ascertained beyond cavil the true nature of lightning—from that time to the present, the protection of buildings and ships from its destructive agency has been mainly a matter of detail and application of the laws of electricity so far as they were known.

For a long time the erection of lightning conductors was opposed by the religious world as heretical and impious. But, first in some Protestant provinces in Germany, and later in France and England, the use of the heretical rods gradually extended. The extension of their use in England and their application to ships, were greatly aided by the labours of that enthusiastic worker, Sir W. Snow Harris. Their extension in our South African colonies, where violent thunderstorms are frequent, is largely due to the influence of the late Dr. Mann, in whose honour this course of lectures has been established. Anyone who has read or heard Dr. Mann's contributions to the *Journal of the Society of Arts*,* must have been struck, not only with his keen interest and enthusiasm but also with his grasp of fundamental principles, his open-minded receptive attitude to new controvertible views, and the thoroughly practical and business-like way in which he handled the subject.

Concerning the origin of atmospheric electricity, I have not much to say. It seems to me probably due to friction, like Armstrong's hydro-electric machine. Faraday showed that the exciting cause in that apparatus of Armstrong's was the friction of water spray driven by steam over the solid surface of the jet; so also I picture winds in the atmosphere driving the spray of mist against rock and ice surfaces, and so gradually producing a certain difference of potential between the upper layers of the atmosphere and the surface of the earth.

I have spoken as if I thought the friction had to be between mist globules and solid matter. It seems doubtful whether friction against *air* will suffice to render water electric. If it is efficient, then it is well to notice that, though there is no finite slip between bodies and the common air through which they move, yet this does not apply to rarefied air. The viscosity of rare air is as great as that of dense, but the slip of solids through it is another matter. In rare air there is an actual slip at the surface, and accordingly the *apparent* viscosity of rare air, as observed by the settling of dust or the falling of a feather in a vacuum, is less than in air at common pressure. It may be, therefore, that the finite slip of mist or dust-particle through the upper layers of the atmosphere is one effective cause of atmospheric electrification; and after a spell of dry weather there is liable to be an

* *Journal of the Society of Arts*, April, 30, 1875, an March, 15, 1878.

accumulation of electricity, because it has had no recent opportunity of escape.

In the polar regions electrical discharges are mainly silent, or brush like, giving the fantastic forms of aurora. But in our latitude these silent discharges in the upper semi-conducting rarefied layers of atmosphere are seldom visible. We see the effect in another form. The electrification gets occasionally conducted down by clouds into the lower and denser layers of atmosphere. By the aggregation of small globules into great ones the potential is enormously raised, until in the lower atmosphere they flash either into each other or into the earth, and the strain is partially relieved.

It is important to note that clouds appear to play only a secondary part in the phenomena. The upper regions of atmosphere are at a different potential from the earth—cloud or no cloud. Clouds are able to conduct it down towards the earth, and thick dense clouds are therefore the usual prelude to a thunder-storm.

The way in which the coalescence of small charged globules into larger globules is competent to raise their potential enormously, is well understood, and I need not dwell upon it;* but the converse operation, or the tendency to coalescence of globules produced by feeble electrical charges in their neighbourhood, is not so well known, and I proceed to show the very simple experiment described by Lord Rayleigh, with a water-jet and sealing-wax.

A vertical jet about one-twentieth of an inch in diameter and three or four feet high does best, but almost any fairly vertical jet of clean water will serve. The drops fall as a scattered shower like fine rain until a stick of excited sealing-wax is held a yard or two away; they then instantly collect into large globules and fall as a thunder shower.

We have now to think of ourselves as living always between the coatings of a large condenser or Leyden jar, the upper coating the sky, the under coating the earth, the common air is the dielectric between. Ordinarily the sparking distance is far too great. Every now and then portions of the upper coating protrude down as clouds, and we are then liable to a disruptive discharge. Some square miles of cloud and some square miles of land are the two coatings, and the interval of separation need not be extremely great. If the cloud and the earth were perfect conductors, all this great area would be relieved in a single flash of awful size; but, fortunately, the conduction of cloud is a slow process, and it usually takes a good many flashes from different parts to remove its charge.

* See a lecture on "Thunderstorms," by Prof. Tait, in *Nature*, August, 1880.

The total maximum energy of a given area of cloud at a given height from the earth is easily estimated, for it is well known that as soon as the electric tension of air reaches the limit of about half a gramme wt. per square centimetre, disruption occurs. Supposing it all equally on the verge of giving way, the energy of the dielectric per cubic centimetre is therefore $\frac{981}{2}$ ergs, and per cubic mile is

$$\frac{4{,}110 \times 10^{12}}{2 \times 3 \times 10^{7}} \text{ foot-tons} = 70{,}000{,}000 \text{ foot-tons.}$$

Given, then, the whole area of cloud facing the earth, and its height when on the point of discharging at every point, and you have the number of cubic miles of strained dielectric, and an approximation to the energy of the storm, at the rate of 70,000,000 foot-tons per cubic mile.

The potential needed to give a spark a mile long is so enormous* that the quantity of electricity required to give this energy need not be very great; $2{,}176 \times 10^8$ electrostatic units of quantity per square mile would give a bursting tension. Now, $2\cdot176 \times 10^{11}$ electro static units is just about 70 coulombs, or not enough to decompose one-hundredth of a gramme (1-7th of a grain) of water. Faraday stated this, but it is often disbelieved.

As to the cause of the curious V-shaped troughs or depressions and horizontal whirls that are often found associated with thunder-storms, I have no suggestion to offer, but on those heads I may refer to Mr. Abercromby's recent little book on the "Weather" (Int. Sci. Series, 1887).

Thinking now of a cloud and of the earth under it as forming the two coats of a Leyden jar, in the dielectrics of which houses and people exist, we have now to consider what determines a discharge, and what happens when the discharge occurs. The maximum tension which air can stand is ½ gramme wt. per square centimetre. At whatever point the electric tension rises to this value smash goes the air. The breakage need not amount to a flash, it must give way along a great length to cause a flash, if the break is only local nothing more than a brush or fizz need be seen. But when

* The difference of potential for a spark a mile long, between flat plates, is roughly 16×10^7 electrostatic units.

a flash does occur it must be the weakest spot that gives way first—the place of maximum tension—and this is commonly on the smallest knob or surface which rears itself into the space between the dielectrics.

If there be a number of small knobs or points, the glows and brushes become so numerous that the tension is greatly relieved, and the whole of a moderate thunder cloud might be discharged in this way without the least violence. This is by far the best way of protecting anything from lightning; do not let the lightning flash occur if you can possibly avoid it. But one cannot always prevent it, even by a myriad of points. A good deal more might be done in this direction than is done, but still, sometimes a cloud will descend so quickly, or it will have such a tremendous store of energy to get rid of, that no points are sufficiently rapid for the work, and crash it all comes at once. One specially noteworthy case when points are no protection occurs when one cloud sparks into another, and thence to the ground; or, in general, whenever electric strain is thrown quite suddenly upon a layer of air. (See Lecture II. for details.)

When a flash occurs, a considerable area is relieved of strain, and the rush of electricity along the cloud and along the ground toward the line of flash, sets up a state of things very encouraging to another or secondary flash or flashes practically simultaneous with the first.

One consequence of this is known as the back stroke or return stroke. It was studied by Lord Mahon, and depicted in his work, "Principles of Electricity," published in 1780. Professor Tyndall has made it extremely well known, so that a reference to it is made in almost every elementary science school in the country.

But the popular account of the matter is, I believe, very inadequate. It says the man's electrical condition is disturbed by the inductive action of the cloud, and that on the cloud being discharged the man's original condition is restored; the passage of the induced charge from his hat to the ground being enough to kill him.

Now the shock that a man could get that way is but feeble; it is only twice what he would get if completely isolated and exposed to inductive action. The amount of charge stored up in a man's hat is not great; the electric tension is more likely to pull his hat off than its release is likely to do him any damage.

I do not deny the existence of this static return shock, but I assert it to be impotently feeble. One can feel all there is to feel by holding a hat near an electric machine till nearly bursting tension, and then discharging the machine. There is no special object in waiting for a thunderstorm.

There is more in the "return stroke" than a mere recovery from statical disturbance of equilibrium. It is a matter to which I must return at some length next week.

Now proceed to the kind of damage done when a building is struck, and to the customary and orthodox modes of protecting them from the effects of the flash when it does occur, as well as if possible of warding off the flash altogether by silent discharge. The two main destructive aspects of a lightning flash are—(1) its disruptive, or expanding or exploding violence; (2) its heat.

The heating effect is more to be dreaded when the flash is slow and much resisted; the bursting effect when conducted well except at a few places. A noteworthy though obvious thing is, that the energy of the discharge must be got rid of somehow. The question is, how best to distribute it. It is no use trying to hocus-pocus the energy out of existence by saying you will conduct the charge to earth quite easily and quietly.

The disruptive effect is well shown by the effect of lightning on trees. It is as if every cell were burst by the expansion in the path of the discharge. The effect on conductors is, however, just as marked. Here are five specimens of wires deflagrated on glass by a Leyden jar discharge; gold, silver, copper, iron, and platinum; each has its characteristic trace, by which it can easily be recognised.

[A number of pictures of damage done to buildings and ships by lightning were here thrown upon the screen. They are mostly contained either in Mr. Anderson's work on Lightning-conductors, or in Mr. Tomlinson's on the Thunderstorm, or in both.]

St. George's, Leicester, is a curious case, for the rod of the vane conducted the flash half-way down the spire, when it blew a ring of stones out, and so dropped the top half of the spire neatly inside the bottom half, making a tremendous smash, carrying away all the floors of the tower, and beating in the foundation-arch.

Ships may have a mast utterly destroyed and split to pieces—thick iron hoops binding the mast being rent asunder and flung about by the force of the expansion; or the heat of

the flash may ignite the sails, or other combustible matter.

Now take a few examples of buildings or ships more or less protected by conductors. Some of these examples are very instructive as calling attention to the vagaries and unexpected behaviour of powerful flashes. It is these vagaries which I consider have been hitherto unexplained, and it is precisely these to which I wish to direct your special attention.

I shall hope to show next week how closely and completely they can be illustrated by laboratory experiments, and I believe that it is to a neglect and misunderstanding of these phenomena that so many of the partial failures of conductors have been due.

For that conductors often fail is undeniable. It is customary to say they are not properly made, or that there was a faulty joint, or that there was a bad earth. A bad earth is the favourite excuse. A good earth is a good thing undoubtedly, and one cannot well have too much of it; but for a flash to leave a fine thick copper conductor on a tall chimney while still high up, and begin knocking holes in the brickwork in order to make use of the soot or the smoke or some bolts or other miserable conductors of that sort, because it is not satisfied with the moderate allowance of earth provided for it at the bottom, is evidence either of simple perverseness or else of something more deep-seated and not yet properly called attention to.

If the earth is bad, the flash can show its displeasure when it gets there by tossing it about, and boring holes into it, and breaking water and gas mains; but at least it might leave the top and middle of the chimney alone, it might wait till it got to the badly conducting place before doing the damage. Yet it is notorious that on high chimneys a flash often refuses to follow a thoroughly good conductor more than a quarter or half way down, but takes every opportunity of jumping out of it and doing damage.* Why is this? Well, that is the main question I shall attempt to answer in this course.

It may be said that the effect of the bad earth is to make the whole path so highly resisting that the discharge necessarily declines to take it. Well, if that were so, it need not have come into the conductor at all. It is supposed with one breath to strike the conductor because it affords an easy path to earth, and with the next it is said to leave the conductor, because after all it finds it a bad one.

Besides it need not be so very particular about a little resistance; it has already come through, say, half-a-mile of clear air, it might manage a few feet of dry soil. It strikes violently through the air, enters the conductor, and begins to go quietly. Why does it not continue to go quietly till it gets to the bottom of the good conductor, and *then* begin displaying its vigour by boring holes below, as it has done above? Why should one end have to be so persistently cockered up? Why not insist upon having not only a good "earth," but also a good "sky"?

Let me repeat, a good earth is a good thing, and it is not possible to have too much of it, except on the score of expense, but even if it were so good an earth that it might be almost called a heaven, it would not stop the tendency to side flash. One would still be liable to spittings out from conductors, especially from tall stout ones, as I shall hope to clearly show next time. However bad an earth may be, it can hardly be worse than one afforded by soot, and bricks, and yards of air.

My position at present is that an earth is desirable to prevent damage to pipes, foundations, and other things buried therein. But that, *so far as getting rid of the flash is concerned*, it ought to suffice if the conductor was cut off level with, or even a foot or two above, the ground. It would knock things about in jumping the rest of the way, but it should not be expected to leave the conductor until it gets to the break, any more than it should be expected to take the conductor half way down instead of at the top. It is true it sometimes *does* partially take the conductor at the middle, just as it sometimes partially leaves it at the middle, but I say that it is not to be expected to do either of these things on ordinarily accepted principles. There are some differences between the behaviour of positive and negative electricity, but none of such extent as will explain the extraordinary difference between the two or three points pointing skywards, and the extensive roots advocated at the other end.

Take these examples now. A house where the lightning, having struck the conductor, flashes off from it in two places to get to a roof gutter and a distant water-butt. Here is a ship where the lightning is striking in two places at once, the top of the mast and the yardarm. In the next it is striking at the

* For an example of the entire failure of a brass rod, 1 in. in diameter, see Anderson's book, p. 137. For cases of capricious leaving of a conductor for such things as safes and fowling-pieces, see pp. 250 and 273.

top of the conductor, and also at a point on deck, and at two places on land as well. This is a most instructive example. I have little doubt that the three are echoes or reverberations of the main flash, and excited by it; not excited by induction as in a coil, still less by mere static return, but by a surging or momentum of electricity, of which I have more to say. The next diagram shows the ship *Conway* capitally protected, except as to its flag-staff. The water was seen to be luminous in conducting away this flash from the sides of the ship. Here is the arrangement by Snow Harris of conductors able to accomplish this protection—simple and effective. A ship is an easy thing to protect, provided you realise that every mast and every spar is liable to be struck. If you protect the masts you may chance the spars if you like; but you are not to think of areas of protection; all such ideas are perfectly illusory.

[Figures of certain houses with elaborate conductors were shown.]

Nothing projecting upwards is left unspiked, and the earths are thorough. These appear to be examples of excellent, though certainly expensive, protection.

If these houses were powder magazines we should have to be more careful still and make a more critical examination, but as ordinary houses they are safe so long as the conductors are in decent condition.

Now rapidly run over ordinary good orthodox conductors. First, the sky end. Points are good, as explained, but platinum points are liable to be melted. The best points are cones of copper, not too sharp, and thickly gilt. Gold is better than platinum in being just as durable and much better conducting, and therefore less liable to melt. Many points are better than one, especially as some are apt to get fused and blunted by some discharge; others may still remain sharp.

True, anything will act as a point when the tension rises high enough, but the great thing is to keep down these dangerous tensions if anyway possible. So soon as a knob begins to emit brushes the sparking point cannot be far distant, but sharp points will glow and reduce the strain far before the sparking point.

Perhaps the best protected building in the world is the Hôtel de Ville at Brussels, the hobby of M. Melsens. The whole system used in this building is excellent and theoretically perfect, so far as I know, in every respect; but it is not cheap, and some people might perhaps hold that it was not artistic.

As for the main conductors, one finds rod, rope, and ribbon. The plan most approved perhaps by the lightning-rod conference is this copper-tape, which is very nice, neat, and flexible, and free from joints.

Two important matters to be thought of in connection with the conductor are—that it shall not corrode away in places, and shall not be stolen. Another point that must not be overlooked in fixing up any length of conductor is that it is liable to expand and contract. An allowance must be left for this. When it is remembered that it is liable to be exposed to the full glare of the sun, backed up sometimes by a kitchen chimney behind, and then again at another time exposed to the coldest nights, a range of 100° Centigrade is not excessive.

I once rigged up some copper rod battery conductors of substantial thickness between two walls, and one morning after a frost found one snapped clean in half by the contraction. This would be a bad thing to happen to a lightning conductor; so either bends must be left in the rope when put up, or else special compensators must be introduced at intervals.

The allowance for copper is 1 in 500; say an inch in every 40 feet. The best place for a compensator is just above a holdfast, so that it will have to support no weight. A bight or bend in a flexible rope answers every purpose, but bends should not be made too sharp, or the discharge will jump across instead of going round. That is a thing to be remembered. Flexible conductors are very convenient, but their convenience must not be abused. Always take them as straight as possible. Lightning has no time to go round circles—it will jump across sooner. Why should it not be let to jump across? Well, because it burns the conductor. That is the real objection to bad joints—the extra heat; a sort of arc produced there, and the liability to fusing and destruction of the conductor at these parts. There is, moreover, some danger from fire.

Now about the earth end. We have had examples of good earths already. Here is a cheap one advocated by Dr. Mann: wire rope opened out into a brush, and the two ends of another short bit, similarly treated, spliced across the first. Two of the fuzzed out ends make contact with deep soil, one with the surface soil, so that one or other is pretty sure to reach moisture.

The whole conductor introduced into the Cape by Dr. Mann, is simple, cheap, and admirable for cottage purposes and for emi-

grants. Squatters in the States, or Canada, or at the Cape, are far more liable to thunderstorms than we are in this country, and they should certainly rig up one of these homely things. A bit of iron fencing rope will do, with both ends fuzzed out, one supported by a tube fixed to the chimney, the other sunk deep into moist ground, or swamp if available.

In towns, where there are water or gas-mains anywhere near the terminus of a lightning-conductor, they should always be connected to it; and this mainly for their own protection. For if they be not connected, the lightning will not scruple to still make use of them if it chooses, and having to jump across a yard or two of bad conductor on the way, it can easily knock a hole in them or melt them, instead of getting to them quietly.

It must be understood that what I say of the mains underground does not apply to the pipes in a house. To connect lead water pipes with a lightning-conductor might possibly lead to their being melted; but to connect the house gas-pipe with a conductor is a most dangerous proceeding. The neighbourhood of gas-pipes in a house must be scrupulously avoided. The more it is connected to the mains underground the better, but one does not want lightning rushing along compo-pipes, picking out all the bad joints, and lighting all the gas there. In so far as a house contains escaping gas, or weak gas-pipes, it must be treated like a powder magazine, and great care be taken. A ridiculously minute spark may ignite gas without being noticed, the hole in the pipe may quietly enlarge, and the house be burnt down. A considerable amount of damage has been done in this way. So soon as Swan lamps are in universal use, lightning may occasionally play havoc with their filaments and fuse a few cut-outs, but it will not find the leads easily combustible or capable of burning the house down.

Whether it be gas or electric light, however, lightning should, if possible, be kept out of the house-leads—not only because of the danger it may do at joints and insulations, but because the gas-brackets and chandeliers are usually conveniently suspended over desks and near arm-chairs, just where an unsuspecting person's head is likely to be; and a spark to one's head is unsafe.

Hitherto I have spoken of the orthodox system of protection, the gather up and carry away system. But, as you know, there is another system suggested by Clerk Maxwell, the birdcage or meat safe principle. In a banker's strong room you are absolutely safe. Even if it were struck nothing could get at you. In a birdcage, or in armour, you are moderately safe. I should not care to try armour myself, the joints might get unpleasantly hot and explosive. And even the birdcage, if struck by a big enough flash, might get melted. A melted patch on one's protective armour would be extremely disagreeable. Sometimes one is told to get thoroughly wet through instead of seeking shelter in a thunderstorm; but it is a question whether a stroke is more unpleasant than rheumatic fever.

However, a sufficiently stout and closely-meshed cage or netting all over a house will undoubtedly make all inside perfectly safe. Only, if that is all the defence, you must not step outside, or touch the netting while outside, for fear of a shock. It would be unpleasant, when you reached home out of a storm, to find it so highly charged as to knock you down directly you tried to go in. An earth connection is necessary as well.

A wire netting all over the house; a good earth connection to it at several points, and a plentiful supply of that barbed wire which serves so abominably well for fences, stuck all over the roof, and you have an admirable system of defence.

Now let us see how far most people agree, and where they begin to branch out and differ. The old and amusing political controversy between knobs and points has disappeared. Points to the sky are recognised as correct; only I wish to advocate more of them, any number of them, rows of them, like barbed wire —not necessarily at all prominent—along ridges and eaves. For a point has not a very great discharging capacity. It takes several points to discharge readily all the electricity set in motion by a moderately-sized Voss or Wimshurst machine; hence, if you want to neutralise a thunder cloud, 3 points are not so effective as 3,000.

No need, however, for great spikes and ugly tridents, so painful to the architect. Let the lightning come to you, do not go to meet it. Protect all your ridges and pinnacles, not only the highest, and you will be far safer than if you built yourself a factory chimney to support your conductor upon. At present the immediate neighbourhood of a factory chimney or steeple is not a safeguard, but a source of mild danger. But no one need believe this till after next Saturday, and not then if the experiments fail.

Next, as to the conductor. Should it be iron or should it be copper? Should it be insulated from the building, or should it be connected with all the metal it contains? These are questions at present in dispute. The lightning-rod conference approves copper, though not putting it specially and strongly before iron. Durability is its main recommendation. Under all circumstances I am not sure whether it is more durable than galvanised iron. Mr. Preece has great experience of wires in chemical and all other districts, and I believe he upholds iron. Franklin, and the Americans to this day prefer iron. Certainly it is much cheaper, and not so easy to melt. We will consider the question, and, I think, come to a definite conclusion next week.

Also the question about connecting up the conductors to all metal masses, roofs, girders, balconies, water gutters, &c., we had better leave that open too. Nearly everyone condemns insulators, but one eminent authority, M. Callaud, advocates caution and circumspection in what things you connect and what you do not connect. He points out, for instance, that if you connect up a balcony to the conductor, a person standing thereon may become one of its striking terminals. I must say I agree with him. Some there are who advocate connecting *both* ends of a roof gutter, or other such nearly closed contour, and not only one end. I decidedly agree with this also, for reasons which next week will make abundantly clear. On this point I have, in fact, no doubt.

As regards the shape of the conductor, whether rod or ribbon? Many experiments have been made, notably some by Mr. Preece on the discharge of Dr. De la Rue's battery through conductors of various sectional shapes, to see if extent of periphery matters. Hitherto the results have been negative. We may conclude, I think, that it does not matter much as regards liability to be deflagrated. But theory clearly points to the fact that a bundle of detached wires is electrically better than a solid rod of the same weight per foot, in every respect except durability. But durability is an essential feature. No shape can be considered satisfactory which aids corrosion. One thing is obvious; plenty of surface encourages cooling, and slightly diminishes danger of melting. Its other much more important advantages we will consider later.

Lastly, the "earth" and its testing. An earth is necessary, or you will have your foundations knocked about and your garden ploughed up. A good earth is desirable. A few tons of coke with the conductor coiled up amongst it is a well known and satisfactory plan if the soil be permanently damp. A bag of salt might perhaps be buried with it to keep it damp throughout, or rain water may be led there. Often, however, the most violent thunderstorms occur after a spell of fine weather, and the soil is likely to be dry. It is best therefore to run your conductor pretty deep, and there make earth.

It is all very well to connect the conductors to water-mains if near, but if they are far off or non-existent it is no use; and in no case, in my opinion, should they be used as sole earths. Certainly not gas mains. In dry weather they are not earthed at all well, and a strong charge may then surge up and down them and light somebody else's gas in the most surprising way. It does not often happen, but it may happen in sandy soil after dry weather. Always there should be a good deep earth—a well if possible, a boring if not—and the conductor be led down into it. If it likes to make a disturbance when it has to leave the conductor a long way down, no one need grumble. It can't do much harm there. There is, of course, no magic in water, unless it forms a large continuous sheet. An isolated puddle in a rock, such as has been used before now for a lighthouse, is no earth at all. A thoroughly good earth is really a geological question; and for an important building a geological specialist should be consulted.

An occasional test of an earth, in ordinary weather, is no real security as to what may happen after a long-continued drought. It would be easy to arrange a plan whereby just raising a handle shall give sufficient information as to the state of the earth, without any skilled operator. To this end, two earths should be provided, quite independent of each other (one a water-main, for instance, the other a ton of coke), and they should be connected, first to each other and then to the conductor, by a substantial copper band. Now let the band connecting the two earths pass through some covered outhouse, and have a well overlapping junction of two flat areas pressed together by a spring, but capable of being raised on or off the other by pulling at a handle or a rope. A galvanometer indicator and Leclanché cell, permanently connected so as to send a current between the two earths directly the handle is raised, will show by its deflection the state of conductivity of the two earths. Very likely the two earths themselves will suffice to

give the necessary current without an auxiliary battery.

There is this to be said, however. If a building is so situated, either on high sandy ground or on impervious rock, that a decent earth is very difficult to get, then, at least, the house is not likely to make a better earth than the conductor. That is a weak point in the excuse so often made concerning an accident to a protected building, that the earth was not sufficiently good. It can very seldom be shown that the earth, apparently chosen in preference, was any better: often it was obviously worse.

It is a superstition to place much reliance on the testing of conductors with a galvanometer and Wheatstone bridge. A galvanometer and Wheatstone bridge are powerless to answer many important questions. A Leclanché cell can no more point out what path lightning will take, than a trickle down a hill-side will fix you the path of an avalanche. The one is turned aside by every trivial obstacle, and really chooses the line of least resistance; the other crashes through all obstacles, and practically makes its own path. A flash strikes a house at one corner, rushes apparently part way down the conductor, then flashes off sideways to a roof-gutter, sends forks down all the spouts, and knocks a lot of bricks out. Another branch bangs through a wall in order to run aimlessly along some bell-wires, and then out through a window-frame, and down a spade or something propped up against the wall to earth. The lightning tester comes with his galvanometer and Leclanché cell, and reports that the earth of the conductor has 100 ohms resistance; and the accident is therefore accounted for. But how much resistance would he have found in the paths which the lightning seemed to choose in preference to the 100 ohms? Something more like a 1,000,000 probably. Or, perhaps, there is a bad joint in the conductor somewhere, the parts being separated by one-sixteenth of an inch. But why should it prefer to jump several yards, and knock holes in walls and windows, rather than jump one-sixteenth of an inch? No; the galvanometer, and Wheatstone's bridge, and Ohm's law, and conductivity, are simply not in it.

Something has been left out of consideration, and something very important too; and until that something is fully taken into account, no satisfactory and really undeniable security can be guaranteed.

That something is inertia—electrical inertia.

Suppose you have a pipe or U-tube full of water, used as perpetual overflow to a cistern, and you want it to be equal to all demands. You test it, and find it perfectly easy to pour the water either way; both ends are perfectly open; the pipe is a good conductor. Then comes some one and hits the stagnant water in your pipe a tremendous blow with a hammer, bursts the pipe, and scatters the water all about. That is what lightning does to your lightning conductor and to the electricity in it. It is no gentle push, it is a terrific blow.

Conductivity is not what you want; widening the pipe is no remedy. There is a something you want; there is a remedy. The remedy is elasticity—electric "capacity." You must reduce the electrical inertia (or self-induction) of your conductor as much as possible, and you must increase its electric elasticity (or capacity) wherever convenient. These are matters concerning which I have many experiments to show next week.

The lecturer exhibited a photograph of Sanderson's climbing ladder for chimneys, which had been kindly lent by Messrs. Richard Anderson & Co. He read (as requested) a letter from Mr. W. McGregor, advocating the formation of a society for the protection of life and property from lightning. And he called attention to a suggestion of the Hon. R. Abercromby's, at the Manchester meeting of the British Association last year, that a systematic observation and record of thunderstorms should be undertaken, so as to gain a knowledge of the distinct types of storm, and modes of circulation of air which accompany them.

He further desired to express his obligation to the following books, for many details and examples of damage done, and of current methods of protection:—"Lightning Conductors," by R. Anderson, third edition, revised by Dr. Mann (Spon). "The Thunderstorm," by C. Tomlinson, F.R.S. (S.P.C.K.). "Report of the Lightning-Rod Conference," edited by G. J. Symons, F.R.S. (Spon). An extensive list of memoirs on the subject is contained both in this Report and in Anderson's book. Dr. Mann's paper in the *Journal of the Society of Arts*, 1875 and 1878.

Miscellaneous.

SILK CULTURE IN IRELAND.

An Association for the Promotion of Silk Culture in the South of Ireland was formed in 1887, with the hope of utilising much good land which now bears

very unproductive crops, and it is said that the river valleys of Munster are especially suited for the growth of the mulberry tree. The present effort to introduce silk cultivation divides itself into two parts—first the cultivation of the mulberry tree, and next the rearing of cocoons. To accomplish these objects of the Association it is proposed, and is actually being done on a small scale, to distribute mulberry trees amongst those who last year reared such silk as to "equal any Italian or other silk" ever seen by Mr. Wardle, of Leek. Count Dandalo, in his Italian work on the silkworm, says that Ireland, from many circumstances, appears peculiarly favourable to the cultivation of silk. The experiment of rearing silkworms is being tried by about thirty families, but large results are not expected at once, as the imported mulberry trees will not leaf well in the first year. It is remarked that if the re-afforesting of Ireland be desirable some of the trees should be the useful mulberry.

Another part of the scheme is to introduce reeling machines, which can be used by ladies in their own homes. Sericulture has been in every country rather an occupation for the family than for the factory, which gives it a special claim to attention, at a time when those whose circumstances forbid them from seeking employment outside their own homes are suffering keenly from the general depression.

The Hon. Treasurer and Secretary of the Association is Mr. M. H. Westropp, Ravenswood, Carrigaline.

THE AMERICAN SPONGE FISHERIES.

At Key West there are owned about 100 vessels, ranging from 5 to 50 tons, costing from £100 to £800, employed in the sponge business, and about 300 boats of less than 5 tons, registered for sponging, costing from £20 to £100 each. The commercial forms of American sponges are specifically identical with those of the Mediterranean. There are five kinds taken by the fishermen, though these may posssibly be subdivided into grades according to their size or other qualifications. They are the sheepswool sponge, the yellow sponge, the velvet or boat sponge, the grass sponge, and the glove sponge. The most valuable of these is the sheepswool sponge, and this, from Florida, now commands a higher price than that from the Bahamas; 3,663 bales, or 207,000 pounds, were shipped in 1883, the total amount paid for them being £50,000.

The Florida sponge-grounds form three separate elongated stretches, along the southern and western coasts of the State. The first includes nearly all of the Florida Keys, the second extends from Anclote Keys to Cedar Keys, and the third, from just north of Cedar Keys to St. Mark's, in Appalachee Bay. The linear extent of these grounds is about 120 miles, and their breadth varies from a few miles to 15 or 20 miles. The total area of the sponge-grounds worked is reckoned about 3,000 square geographical miles, but this does not by any means cover the possibilities of the coast, as many additional sponging areas have been discovered lately.

Sponge culture has of late attracted the attention of those engaged in Key West fisheries. The experiments made seem to indicate that the culture of sponges may be made remunerative in the waters of Florida. The process is comparatively simple; a sponge is hooked from the bottom and brought to the surface of the water, but is never lifted into the air. It is then clipped into small pieces and fastened on a wire or stick, which is afterwards fixed to the bottom as firmly as practicable. For the first four months the "clippings" do not show any increase in size (it taking them this length of time to recover from the injury done by cutting), but later they develop with considerable rapidity.

Of the American sponges, a very small quantity comes to Europe; out of 1,371,000 lbs. imported into the kingdom in 1886, only 202,300 lbs. came from the United States. The bulk of our supplies, 1,000,000 lbs., are from the Mediterranean, Greece, and Turkey. The value of those imported in 1886 was £230,000.

DISCOVERY OF EXOTIC FLAX.

Consul Williams, of Rouen, says that M. J. de Turck, of Lille, who is a manager of spinning mills, has brought to light a textile plant of Chinese origin, which has some analogy with ramie. He claims to have discovered a process for degumming this textile, which comes already decorticated, and to produce from it threads of great strength and beauty. He has termed the textile *lin exotique*. It is claimed for this material that in its native country its cost is from 3d. to 3½d. a kilogramme, and from 4d. to 5d. laid down at Marseilles, whereas flax costs, according to quality, from 10d. to 1s. 9d. per kilogramme. The exotic flax, without assorting, is fit for the coarsest fabrics or the finest, the latter only requiring the usual more careful and complicated preparation. The finest lace and the strongest cord can be made from it, as well as an infinite variety of intermediate fabrics, such as tablecloths, napkins, carpets, plush, wearing apparel, &c. It is spun without combing, thereby saving 40 per cent. of waste incident to flax combing. The material can be worked with the ordinary flax machinery. The textile can be mixed with flax, silk, wool, and cotton. Its strength is very great, and a sewing thread can be spun which requires no twisting. The refuse is utilised and can be worked in the same manner as cotton, which it closely resembles. If desired, the long fibre can be broken up by an ordinary crusher and reduced to the usual length of cotton fibre. Consul Williams adds that the various fabrics made

from this plant, which can be seen at Lille, appear to indicate beauty, strength, and general utility. The plant utilised by M. de Turck in his invention is the dolichos of Tonquin (the dolichos catjang of Cochin China). This is cultivated every where throughout Tonquin, and bears also the name of *dâu*. The plant produces the dolique, or Tonquin bean, and, next to rice, is the most important crop of the country. It is cultivated on thousands of acres of land bordering on the sea by the side of the rice swamps of Hung-hoa, and the banks of all the rivers. The seed is sown in February and March in the north, and a little later in the south. When inundations are feared, the dolique is planted alone, or with other seeds to form clusters, in the latter case Indian corn or castor beans are planted, as in addition to the shade which they afford, they produce a valuable crop. This crop is suitable to lands which are too elevated or too porous for rice. It is also cultivated as an alternate crop with rice, to prevent the exhaustion produced by two successive rice crops on the same land. It is cultivated also to rid the land of weeds. It usually ripens about the first of May, or a month earlier than the rice crop. At the time of harvesting the dolique, the country is overrun with women and children gathering the ripe pods in small baskets. The men in long files are seen wending their way to their villages, with long bamboo sticks upon their shoulders, on the ends of which the baskets are balanced. As there is no rest for the land in Tonquin, the stalks are buried with the plough. Occasionally a few are saved for fuel, bedding for the buffaloes, or for manure; but the quantity thus used is small.

General Notes.

Electric Light in the Suez Canal.—Consul Burrell, of Port Said, gives the number of vessels with the electric light passing through the canal in 1887 as 395, made up as follows:—January, 13; February, 12; March, 15; April, 19; May, 19; June, 25; July, 27; August, 35; September, 45; October, 49; November, 63; December, 73. The average time of the transit of the canal in 1887 is given as 33 hours 58 minutes, as compared with 36 hours in 1886. The shortest time taken by an ordinary steamer with the electric light for night navigation was 15 hours 5 minutes.

National Association for the Advancement of Art.—An Association for this purpose was formed at a meeting held at Grosvenor-house (with the Duke of Westminster, K.G., in the chair), on Friday afternoon, 8th inst. The first annual meeting is to be held at Liverpool, in November next. The President of the Association is Sir Frederick Leighton, Bart., P.R.A., and the following is a list of the Presidents of Sections:—A.—Painting—L. Alma-Tadema, R.A. B.—Sculpture—Alfred Gilbert, A.R.A. C.—Architecture—Professor Aitchison, A.R.A. D.—Applied Art—Walter Crane. E.—Art History and Museums—Sidney Colvin. F.—National and Municipal Encouragement of Art—The Right Hon. A. J. Mundella, M.P. The Hon. Secretary of the Association is Professor W. M. Conway.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 18...Asiatic, 22, Albemarle street, W., 4 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Professor G. E. Post, "The Botany of Syria."

Tuesday, June 19...Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, June 20...SOCIETY OF ARTS, Coversazione at the South Kensington Museum, 8½ p.m.
Metereological, 25, Great George-street, S.W., 7 p.m.
Geological, Burlington-house, W., 8 p.m. 1. Mr. James W. Kirkby, "The Occurrence of Marine Fossils in the Coal Measures of Fife." 2. Mr. J. R. Kilroe, "Directions of the Ice-flow in the North of Ireland, as Determined by Observations of the Geological Survey." 3. Mr. John Spencer, "Evidence of Ice Action in Carboniferous Times." 4. Miss Margaret I. Gardiner, "The Greensand Bed at the Base of the Thanet Sand." 5. Rev. O. Fisher, "The Occurrence of *Elephas meridionalis* at Dewlish, Dorset." 6. Mr. Frank Rutley, "Perlitic Felsites from the Herefordshire Beacon, and the possible Origin of some Epidosites." 7. Dr. H. J. Johnston-Lavis, "The Ejected Blocks of Monte Somma." (Part I.) Stratified Limestone.
Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Annual Conversazione.

Thursday, June 21...Royal, Burlington-house, W, 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m.
Chemical, Burlington-house, W., 8 p.m. 1. Dr. W. H. Perkin, "Chlorofumaric and Chloromaleic Acid, their Derivatives and Magnetic Rotations." 2. Messrs. C. F. Cross and E. J. Bevan, "Combustion by means of Chromic Anhydride." 3. Dr. G. T Moody, "Metoxylen Sulphonic Acids." 4. Dr. H. E. Armstrong, "Researches on Isomeric Changes." 5. Mr. D. N. Collie, "A New Method for the Production of Mixed Tertiary Phosphines."
Historical, 11, Chandos-street, W., 8½ p.m. Mr. C. A. Fyffe, "Passages from Unpublished Records of the Napoleonic Period."

Friday, June 22...United Service Inst., Whitehall-yard, 3 p.m. Captain W. H. James, "Fire Discipline and the Supply of Ammunition in the Field as provided for by Foreign Powers."
Quekett Microscopical Club, University College, W.C., 8 p.m.

Saturday, June 23...Physical, Science Schools, South Kensington, S.W., 3 p m. Prof. S. P. Thompson, "Note on Continuous Current Transformers."
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,857. Vol. XXXVI.

FRIDAY, JUNE 22, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws :—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1888.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs Coutts and Co., 31st May, 1887	722 16 9	
Do. in hands of Secretary	19 19 4	
		742 16 1
,, Subscriptions received during the year from Members and Institutions in Union	6,058 5 0	
Life Compositions	588 0 0	
		6,646 5 0
,, Dividends and Interest		796 7 4
,, Ground Rents		174 0 0
,, Examination Fees		286 10 6
,, Advertisements		1,237 7 10
,, Grant from the Foreign-office for promoting the Barcelona Exhibition		50 0 0
,, Donation from the Widow of the late Dr. Mann towards a course of Special Lectures		20 0 0
,, Imperial Institute (repayment of expenses for collection of subscriptions)		39 3 9
,, Entrance Fees for Prime Motors Competition		165 0 0
,, Sales, &c. :—		
Barry's Etchings	12 6	
Cantor Lectures	18 6 11	
Conversazione Tickets, 1887 (including sum paid by Royal Colonial Institute for use of fittings)	271 4 0	
Examination Papers	2 9 3	
Fees for use of meeting-room	41 9 6	
Japanese Exhibition Catalogues (including a portion of the cost paid by Mr. Ernest Hart)	10 11 10	
Journal	154 11 8	
Public Health Conference Reports	3 6	
Spoiled Post-cards	3 3 0	
		502 12 2
		£10,660 2 8

Cr.

	£ s. d.	£ s. d.
By House :—		
Rent, Rates, and Taxes	358 7 0	
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	291 0 8	
Repairs and Alterations	75 16 7	
		725 4 3
,, Office :—		
Salaries and Wages	2,099 13 6	
Stationery, Office Printing, and Lithography	258 7 7	
Advertising	73 13 0	
Postage Stamps, Messengers' Fares, and Parcels	196 19 2	
		2,628 13 3
,, Library, Bookbinding, &c.		90 7 3
,, Conversazione (1887)		601 10 3
,, *Journal*, including Printing, Stamps, and Distribution		2,342 4 8
,, Advertisements (Agents and Printing)		525 7 8
,, Examinations		328 1 3
,, Medals :—		
Albert	55 5 1	
Society's	25 16 0	
		81 1 1
,, Art Workmanship Prizes		219 3 3
,, Owen Jones Prizes		5 16 0
,, Cantor Lectures		260 3 6
,, "Mann" Lectures		40 0 0
,, Prof. Herkomer's Lectures		30 0 0
,, Juvenile Lectures		17 18 5
,, Sections :—		
Applied Art	60 19 0	
Foreign and Colonial	61 4 0	
Indian	69 5 0	
		191 8 0
,, Barcelona Exhibition, advertising, &c.		13 16 5
,, Committees :—		
Prime Motors	1 3 9	
General expenses	13 15 6	
		14 19 3
,, Canal Conference		8 12 6
,, Imperial Institute (balance of charges of Collection, 1887)		14 6
,, Investments :—		
New Consols (Life Compositions of the year)	588 0 0	
Natal 4 per Cent. Stock (from income of the year)	520 0 6	
Deposited with Messrs. Coutts and Co. (accumulation of interest on Trust Funds)	100 0 0	
		1,208 0 6
		9,333 2 0
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1888	1,308 14 0	
Do. in hands of Secretary	18 6 8	
		1,327 0 8
		£10,660 2 8

Liabilities.

	£ s. d.	£ s. d.
To Accounts due	437 15 10	
,, Rates	50 0 0	
,, Examiners' Fees	166 4 0	
,, Sections :—Applied Art, Foreign and Colonial, and Indian	180 0 0	
,, Accumulations under Trusts (£300 of this amount is placed on deposit at Messrs. Coutts and Co.)	369 6 6	
,, Balance of Grant for Barcelona Exhibition	36 3 7	
		1,239 9 11
Excess of Assets over Liabilities		15,835 3 4
		£17,074 13 3

Assets.

	£ s. d.	£ s. d.
By Society's Funds invested in—		
£7,547 1s. 6d. New Consols, worth on 31st May, 1888	7,509 6 10	
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May, 1888	251 14 5	
£1,500 Queensland 4 per Cent. Bonds, worth on 31st May, 1888	1,567 10 0	
£500 Canada 4 per Cent. Stock, worth on the 31st May, 1888	565 0 0	
£530 10s. 1d. New South Wales 3½ per Cent. Stock, worth on 31st May, 1888	551 14 6	
£500 South Australia 4 per Cent. Stock, worth on 31st May, 1888	540 0 0	
£500 Natal 4 per Cent Stock, worth on 31st May, 1888	517 10 0	
		11,502 15 9
,, Subscriptions of the year uncollected	674 0 0	
,, Arrears, estimated as recoverable	250 0 0	
		924 0 0
,, Property of the Society, including Barry's Pictures and Lease of House		2,000 0 0
,, Advertisements on the Books, due and in course of execution*		1,020 16 10
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1888		1,308 14 0
,, Do. on Deposit (Interest on Trusts)		300 0 0
,, Do. in hands of Secretary		18 6 8
		£17,074 13 3

* A portion of this sum is subject to charges for printing.

Investments, &c., Standing in the Name of the Society.

Ground Rents	£4,590 0 0
New Consols	9,118 7 6
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500 0 0
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150 0 0
Bombay and Baroda do. do.	2,450 0 0
Canada 4 per Cent. Stock	923 0 0
South Australia 4 per Cent. Stock	605 16 0
New South Wales 3½ per Cent. Stock	530 10 1
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Queensland 4 per Cent. Bonds	1,500 0 0
Natal 4 per Cent. Stock	500 0 0
Cash on Deposit with Messrs. Coutts and Co.	300 0 0

Trust Funds included in the Above.

1. Dr. Swiney's Bequest	£4,500 0 0	Invested in ground-rents, and chargeable with a sum of £200 once in five years.
2. John Stock Trust	100 0 0	New Consols, chargeable with the Award of a Medal.
3. Benjamin Shaw Trust for Industrial Hygiène Prize	133 6 8	,, ,, ,, Interest as a Money Prize.
4. North London Exhibition Trust	192 2 1	,, ,, ,, ,, ,,
5. Fothergill Trust	388 1 4	,, chargeable with the Award of a Medal.
6. J. Murray, in aid of a Building Fund	54 18 0	,,
7. Subscription to an Endowment Fund	562 2 2	,,
8. Dr. Aldred's Bequest	140 15 9	,, chargeable with the Award of a Prize.
9. Thomas Howard's Bequest	500 0 0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10. Dr. Cantor's Bequest	4,600 0 0	Bombay and Baroda and Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock. Interest applied to the Cantor Lectures.
11. Owen Jones Memorial Trust	423 0 0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12. Mulready Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13. Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14. Accumulated Interest on Trust Funds	300 0 0	On Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.

Payments set forth above have been made by authority of the Council.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

W. R. Malcolm, } *Treasurers.*
B. Francis Cobb, }

H. Trueman Wood, *Secretary.*

J. Oldfield Chadwick, F.C.A., *Auditor.*

Society's House, Adelphi, 18th June, 1888.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-fourth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 27th June, at 4 p.m.

(By order of the Council)

H. TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening last, 20th inst.

The Courts and Corridors of the Ground Floors, and the Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the William Smith Collection of Water Colour Drawings, the Dyce and Foster Pictures, and "The Chantrey Bequest," were open.

The Reception was held in the West Architectural Court by Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Chairman, and the following Vice-Presidents and Members of the Council:—Mr. William Anderson, Mr. Charles Barry, Sir Edward Birkbeck, Bart., M.P., Mr. Alfred Carpmael, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., General Donnelly, C.B., Sir Henry Doulton, Mr. W. H. Preece, F.R.S., Sir Owen Roberts, and Mr. E. C. Robins.

Promenade concerts were given by the band of the Royal Artillery (Conductor, Cav. L. Zavertal) in the North Court, and by the Blue Hungarian Band (Leader, Berkes Bela) in the East Architectural Court.

BAND OF THE ROYAL ARTILLERY.

1. March .... "Hussiten" .... Ferron.
2. Overture .... "No. 2" .... Kalliwoda.
3. Valse .... "Die Publicisten" .... Strauss.
4. Selection .... "La Traviata" .... Verdi.
5. Song .... "Si tu m'aimais" .... Denza.
(Cornet Solo.)
6. Gavotte ... . "Old Edinburgh" ...... L. Zavertal.
7. Descriptive Piece. ...... "The Mill in the Black Forest." ...... Eilenberg.
8. Selection .... "Mignon" .... Thomas.
9. Valse .... "Toujours ou Jamais" ... Waldteufel.
10. Gavotte de la Princesse.......................... Czibulka.
11. Ave Maria .... Schubert.
12. Selection "Le Postillon de Longjumeau" Adam.

God Save the Queen.

BLUE HUNGARIAN BAND.

1. Marsch...... "Hoch im Deütschmeister"
2. Walzer.................. "Wiener"........... Strauss.
3. Ungarische Melodie................................ Berkes Bela.
4. Walzer.................. "Potpourri" .... Czibulka.
5. Ungarische Tanze........... .... Berkes Bela.
6. Polka...................... "Valeri" .... Bolonon.
7. Marsch............... "Tannhauser" .... Wagner.
8. Cimbal Duett .... Pinter Brothers
9. Walzer.................."Don Cezár" .... Strauss.
10. Ungarisches Lied .... Berkes Bela.
11. Potpourri..............."Masaniello"......... Auber.
12. Violoncello Solo .... Balog Bandi.
13. Marsch.................. "Rakoczi" .... Cinkipani.

A vocal and instrumental concert was given by the Neapolitan Quartette (Leader, Signor Talamo) in the Lecture Theatre.

THE NEAPOLITAN QUARTETTE.

PART I.
(9.15 p.m. to 9.45 p.m.)

1. Marcia..............."L'Addio a Drest"........... Caccavajo.
2. Coro..................... "Trafanella" .... Guido.
3. Valzer ...."Il Primo Amore"............ Pecci.
4. Coro...................."Margaretella" .... Di Capua.

PART II.
(10 p.m. to 10.45 p.m.)

1. Funicoli e Mandolinata .... Talamo.
2. Solo..................... "Deh! ti desta" .... Tosti.
3. Marcia......"Il Passaggio del Reggimento" Talamo.
4. Coro......................... "Carolina" .... Costa.

PART III.
(11 p.m. to 11.30 p.m.)

1. Mazurka ...."Non l'Amo Più" .... Talamo.
2. Coro.................. "La Luna Nava" .... Costa.
3. Serenata............... "Marinaresca" .... Giannini.
4. Coro................."Funiculi, Funiculi" .... Denza.

A performance by the Royal Criterion Hand-Bell Ringers and Glee Singers (Conductor, Harry Tipper), was given at intervals in the Casts Court.

ROYAL CRITERION HAND-BELL RINGERS AND GLEE SINGERS.

PART I.
(9.15 p.m.—9.50 p.m.)

1. Bells .... March from "Athalie" ... Mendelssohn.
2. Part Song ...... "Hail to the Chief"...... Bishop.
3. Part Song .... "Absence"............ Hatton.
4. Bells .... "Le Charme Gavotte"... Le Thière.
5. Part Song .... "I wish to Tune" ...... Walmsley.
6. Bells ....Selection of Welsh Airs.

PART II.
(10 p.m.—10.35 p.m.)

1. Bells "March from "Eli," with variations Costa.
2. Part Song ...."Banish, O Maiden" ... Lorenz.
3. Glee .... "Crabbed Age and Youth" Stevens.
4. Bells ..."Imitations of Village Chimes ...
5. Selection .... "Robin Hood"......... Hatton.
6. Bells "Blue Bells of Scotland," with variations.

PART III.

(11 p.m.—11.30 p.m.)

1. Bells............ { Selections from "Lucrezia Borgia" &c. } Donizetti.
2. Part Song ... "O hush thee, my babie"... Sir A. Sullivan.
3. Part Song ... "Love's Good Morrow" ... Reay.
4. Bells .... Selection of Irish Airs. ...
5. Trio ...."Gipsies Laughing Chorus" Glover.
6. Part Song ... "Good Night, Beloved"... Hatton.
7. Bells .... "God Save the Queen." ...

The number of visitors attending the *Conversazione* was 2,232.

Proceedings of the Society.

DR. MANN LECTURES.

PROTECTION OF BUILDINGS FROM LIGHTNING.

BY PROF. OLIVER J. LODGE, D.SC., F.R.S.

Lecture II.—Delivered March 17, 1888.

I made several assertions last week which it is my business now to justify by actual experiment.

The word "inertia" one uses as conveying a correct general notion of the behaviour of an electric circuit to sudden electromotive forces; a behaviour which is caused by the influence or induction which every portion of a circuit exerts on every other portion. Consider a conducting rod as analysed into a bundle of parallel wires or filaments, and let a current be suddenly started in all. The rising current in any one filament exerts an opposing force on all the others; and this self-generated opposition E.M.F., due to induction between the different filaments of the conductor, exactly imitates the effects of ordinary inertia as observed in massive bodies submitted to sudden mechanical forces. (For some illustrations of these well-known effects see a letter by Mr. Maclean in *Nature* (vol. 37, p. 612).

The term commonly employed to denote the electrical inertia-like effect is "self-induction;" which is becoming gradually shortened to "inductance;" its original form when first dealt with by Sir William Thomson was the "electromagnetic capacity" of the circuit.

Now since electric inertia is due to a mutual action between the filaments into which a conductor may be supposed divided, it is manifest that the closer packed they are the greater their inertia will be; and that to diminish inertia it is only necessary to separate the filaments and spread them out.

The main count of the indictment against ordinary procedure is, that too much attention has been hitherto paid to conducting power, and too little to inertia. In fact, it is not too much to say that practically nothing but conductivity has been attended to, or thought of, in the erection of lightning-conductors.

I want to show that conductivity is, from many points of view, of hardly any moment, and that the circumstances of a discharge are regulated far more by inertia than by conductivity. I can even show that, under certain circumstances, high conductivity appears to be an actual objection, and that a stout rod of good conducting copper carries off a flash less well and quietly than a thin wire of badly-conducting iron.

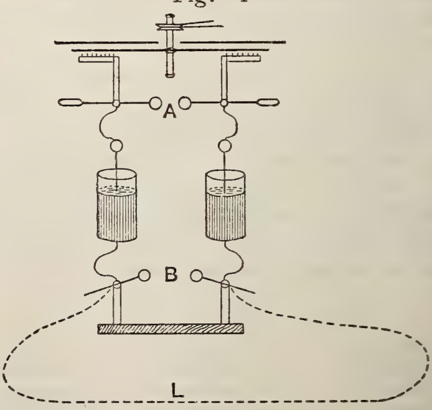
Let us proceed to verify this parodoxical statement at once.

EXPERIMENT OF THE ALTERNATIVE PATH.

The first form of experiment I have to describe is a very simple one. I call it the experiment of the alternative path. It consists in giving a Leyden-jar discharge the choice between a certain conductor and a certain length of air, and in adjusting the length of air until it had as lief take one path as the other.

I am not aware that the particular mode of carrying out this simple experiment has any special significance, but, to be definite, I depict, in Fig. 1, the symmetrical arrangement I have most frequently, though not exclusively, adopted.

Fig. 1



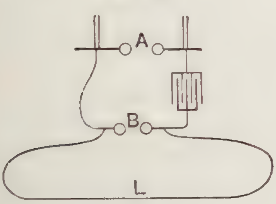
The knobs marked A are the ordinary terminals of a Voss machine. The jars stand on an ordinary wood table, and their outer coats

are led to the discharger, B, the distance of whose air-space can be varied. The alternative path, L, is shown by a dotted line. The discharge has to choose between B and L. Sometimes L is absent, and in that case the charging of the jars is quite well effected through the wood of the table; this is the advantage of having the jars imperfectly insulated. At the same time the conducting power of the wood is too low to enable the jars to discharge themselves at all satisfactorily, unless the knobs, B, are within striking distance, or unless some path, L, is provided. The only discharge obtained at A when both paths, B and L, are absent, is a feeble spitting or intermittent and frequent sparking, very different from the loud report heard as soon as the knobs, B, are brought within striking distance. But it is not to be supposed that the B knobs must be as close together as the A knobs, in order to permit complete discharge; on the contrary, the B knobs may be almost twice as far apart as the A knobs, and yet the discharge shall be complete and noisy.

It will be understood that the two sparks occur together; a spark at A precipitates, and is the cause of, the spark at B. Not *vice versâ*, for until the A spark occurs there is not the slightest tendency for a spark at B. The two B knobs are at the same zero potential, and may be touched with impunity except at the instant when the flash occurs at A. Remember that the jars are standing on a common table all the time.

Lest it be thought that there is anything occult in this mode of obtaining the spark at B, let us subjoin as Fig. 2 another arrange-

FIG. 2.



ment of connection, which does just as well, and, in fact, represents the first experiment I tried. The condenser is a very large one of tinfoil and glass plates, with carefully insulated terminals. My object in making it was to obtain a sudden rush of a considerable quantity of electricity (like lightning), and then study its behaviour under various circumstances. I found afterwards that for most experiments an ordinary gallon or even pint Leyden jar served just as well, was much quicker in use, and less dangerous. Moreover, the use of insulated terminals necessitates the continued presence of some alternative path (L) or other, else of course the condenser declines to charge.

It may be noted at once that with either arrangement the spark A was very loud whenever the spark was allowed to occur at B as well; but so soon as the discharge was compelled to traverse the alternative conductor, L, by putting the B knobs too far apart, then the noise of the discharge was much diminished, not merely because there is now only one spark instead of two, but plainly because, for some reason or other, the discharge meets with considerable obstruction in the wire, whereby its duration is lengthened, and its noise therefore very greatly lessened.

The numbers given below are extracted from a page of the laboratory note-book, and refer to an experiment with two Leyden jars, of a size which I sufficiently specify by calling them "gallon" jars, arranged as in Fig. 1. The length of the A spark was maintained at one inch throughout the experiment; or as it happened to be accidentally convenient to measure lengths in tenths of an inch, I will call the A length 10. The B length is variable, being altered until a B spark sometimes passes and sometimes misses.

The first alternative path I show is a length of about 40 feet of stout No. 1 (B.W.G.) copper wire or rod, suspended round the room by silk ribbon. Its resistance to ordinary currents is very small, being ·025 ohms. Nevertheless, we shall find that the discharge refuses to take this apparently easy path, and persists in jumping the air gap B instead, until the B knobs are separated 14·3 tenths of an inch. This is the critical distance. If they are further apart than this, the discharge chooses the thick copper wire by preference, and its noise or suddenness is then much less.

As a contrast with this, I next try a similar length of fine iron wire (No. 27, B.W.G.), whose resistance to ordinary currents is 33·3 ohms, or 1,300 times as great as the other. We find that the discharge very distinctly prefers this wire to the other. For if the B knobs remain at the distance 14·3 we never now get a B spark, nor do we get one until they have been brought distinctly nearer. The critical spark length is now 10·3. I confess I was surprised at this result.

Let us next try an enormous resistance—a

capillary tube of liquid (very dilute acid), giving to ordinary measurements some 300,000 ohms. The critical spark length at B is indeed a little increased by this great resistance, but not much above that found for the stout copper wire. I have not an exact measure of it, but 16 or 17 will not be far out. The spark at A now becomes very quiet indeed, pointing to the fact that what we were observing all along was, in some sense or other, the effect of true resistance; for the undeniable resistance in the capillary tube gives just the same kind of effects as does the copper or iron wire, only a little more pronounced.

I have suspended three other conductors of about the same length, which it is easy to try in the same way, keeping the A spark-length 10 all the time. The results are here summarised:—

Alternative Path.		Critical B spark-length.
Stout copper wire, No. 1	R = ·025 ohm	14·3
Ordinary copper wire, No. 19	R = 2·72 "	13·4
Stout iron wire, No. 1	R = ·086 "	10·8
Ordinary iron wire, No. 18	R = 3·55 "	10·8
Thinnest iron wire, No. 27	R = 33·3 "	10·3

The copper wires seem to obstruct almost equally, and the iron wires also obstruct equally among themselves, notwithstanding their very different diameters; but the coppers obstruct more than the irons.

There is nothing absolute about these numbers; they are the record of a definite experiment, but their precise value depends on the circumstances of the experiment. It is easy to arrange it so that the iron is less effective than the copper—so that, in fact, ordinary resistance seems to become of consequence again. This is done by putting a long lead into the A circuit of the jars. But whenever the flash is made as sudden as possible—and there seems little doubt but that a lightning flash is very sudden—then the order of the numbers is something like the figures quoted.

Reason of the Enormous Obstruction offered by a Good Conductor.

Now, what is the cause of all this astonishing obstruction offered by good conductors to the sudden rush of electricity? One may express it in a popular way, thus:—It is due to electrical inertia, or what is also called "self-induction." A current cannot start in a conductor instantaneously, any more than water in a pipe can start moving at full speed in an instant. Give the water a violent blow to make it move, and it resists like a solid. The blow, if very quick and violent, may burst the pipe, but it will not appreciably propel the water. So, in a manner, is it with electricity. The flash occurs, and the conductor must either carry it off at once or not at all. There is no time to think about it, and the E M F needed to overcome this inertia-like obstruction is so great, that a considerable thickness of air may be burst by it, and the discharge may flash off sideways to anything handy.

Another way of putting the matter is this:—A lightning discharge is essentially a varying current; it manifestly rises from zero to a maximum, and then dies away again, all in some extremely small fraction of a second, say 100,000th, or thereabouts. But that is not all; there is a certain amount of energy to be got rid of, to be dissipated, and it may easily be that a single rush of electricity in one direction does not suffice to dissipate all the stored-up energy of the charged cloud. If the conductor is highly resisting, a single rush is sufficient, but if it be well-conducting it is quite insufficient. What happens then? The same as would happen with compressed air or other fluid rushing out of an orifice. If it is a narrow jet, there is a one-directioned blast; but if a wide, free mouth be suddenly opened, the escaping air overshoots itself by reason of inertia, and springs back again, oscillating to and fro till the stored-up energy is dissipated. Just so is it with an electric discharge through good conductors; it is not a mere one-directioned rush, it is an oscillation, a surging of electricity to and fro, until all the energy is turned into heat.

This fact is often forgotten by lightning-rod men; they speak as if there were a certain quantity of electricity to be conveyed to earth and there was an end of it; but they forget the energy of the electric charge, which must be got rid of somehow. If a great weight, or a large reservoir of water, were propped up above one's house, one would not say that, the safe thing being to get it down as quickly as possible, it was advisable to knock the props away, or to blow the bottom out of the reservoir; no, one would prefer to let it slide slowly and gradually down a well-resisting channel, so as to disperse the energy gradually.

We will remember, then, that a Leyden-jar discharge through good conductors is oscillatory, and that the oscillation continues until all the stored energy is rubbed away. The oscillations have an enormous frequency; they may be millions a second, for the whole

lot of them have to cease during the excessively minute duration of the visible flash. It is well known that a flash is of far less real duration than the persistence of optical impression on the retina would lead one to believe; as is easily illustrated by illuminating a spinning wheel by an electric spark. However fast (ordinarily speaking) the wheel is spinning it appears to be stationary, and the spokes are seen singly and clearly by the light of each spark.

It is for this reason that, although the illuminating power of a powerful flash need not be greater than weak moonlight, its actual intensity while it lasts may exceed strong sunlight, and hence may exert a damaging effect on the retina, and cause blindness.

There is another fact which it behoves us to be aware of. It is one to the importance of which the attention of scientific men has but recently been called. Experimentally it has been discovered by Professor Hughes, theoretically by Mr. Oliver Heaviside, Lord Rayleigh, and Professor Poynting; for though the necessary theory is really contained in Clerk Maxwell, it required digging out and displaying. This has now been abundantly done, but the knowledge has scarcely yet penetrated to practical men; indeed, it has not yet been thoroughly assimilated by most physicists. The fact is this. When a current starts in a conductor, it does not start equally all through its section, it begins on the outside, and then gradually though rapidly penetrates to the interior. A steady current flows uniformly through the whole section of a conductor, a variable current does not. It is started first at the surface, and it is stopped first at the surface.

Remembering the rapidly oscillating character of an electric discharge, remembering also the fact that a rising current begins on the outside surface of a conductor, we perceive that, with a certain rate of alternation, no current will be able to penetrate below the most superficial layer or outer skin of the conductor at all. In the outer skin, of microscopic thickness, electricity will be oscillating to and fro, but the interior of the conductor will remain stolidly inert and take no part in the action.

Thus we arrive at a curious kind of resistance, caused by inertia in a roundabout fashion, and yet a real resistance, a reduction in the conducting substance of a rod, so that no portion except that close to the surface can take any part in the conduction of these rapidly alternating currents or discharges. It must naturally be better, therefore, not to make a lightning conductor of solid rod, but to flatten it out into a thin sheet, or cut it into detached wires; any plan for increasing surface and spreading it out laterally will be an improvement.

Perhaps it may be as well to guard against one favourite misconception. It has long been known that static charges exist only on the surface of conductors; it has also long been known that ordinary currents flow through the whole section and substance of their conductors. It is now beginning to be known that alternating currents may be sufficiently rapid to traverse only the outer layers of conductors, and this last piece of knowledge is felt to be rather disturbing by those who have been accustomed to dwell upon the behaviour of steady curents, and seems like a return to electrostatic notions, and an attempt to lord it over currents by their help. But the first and third facts mentioned above—the behaviour of static charges, and the behaviour of alternating currents—are two distinct facts, independent of each other; not rigorously independent perhaps, but best considered so for ordinary purposes of explanation.

We have thus mentioned two causes of obstruction met with by rapidly oscillating currents trying to traverse a metal rod. First there is the direct inertia-like effect of self-induction to be added to the resistance proper; the resulting quantity being called by Mr. Heaviside "impedance," to distinguish it from resistance proper. For there is a very clear distinction between them; resistance proper dissipates the energy of a current into heat, according to Joule's law; impedance obstructs the current, but does not dissipate energy. Impedance causes tendency to side flash, resistance causes a conductor to heat and perhaps to melt. The greater the resistance of a conductor, the more quickly will the energy of a discharge be dissipated, its oscillations being rapidly damped; the greater the impedance of a conductor, the less able is it to carry off a flash, and neighbouring semi-conductors are accordingly exposed to the more danger. Resistance is analogous to friction in machinery; impedance is analogous to freely suspended massive obstruction, in addition to whatever friction there may be. To slowly changing forces friction is practically the sole obstruction; to rapidly alternating forces inertia may constitute by far the greater part of the total obstruction; so much the greater part that friction need hardly matter.

This is a fairly accurate popular statement of the direct way in which self-induction aids resistance proper in obstructing an alternating current. But, in addition to these considerations, there is that other indirect way which we have also mentioned, viz., the fact that conduction of alternating current may be confined to the surface of a rod or wire if the alternations are rapid enough. This cause must plainly increase total impedance; for the total channel open to such a current is virtually throttled, as a water pipe would be throttled by a central solid core.

But which part of the total impedance does it affect? Does it increase the resistance part or the inertia part? In other words, does this throttling of a conductor act by dissipation of energy or by mere massive sluggishness? Plainly, it must act like any other reduction of section, it must increase the resistance, the dissipating power of a conductor, the heating power of a current. Hence the resistance of which we have spoken as entering into the total impedance has by no means the same value as it has for steady currents, and as measured by a Wheatstone bridge. It is a quantity greater—possibly much greater—than this; and in order to calculate its value, we must know not only the sectional area and specific conductivity of the conductor but also the shape of its section, and the rate of alternation of the current to be conveyed.

Tape *v.* Rod.

We may here note a vigorous controversy, or difference of opinion, between Faraday on the one hand, and Sir W. Snow Harris on the other. Faraday was often consulted about lightning conductors for lighthouses, and consistently maintained that sectional area was the one thing necessary, weight per linear foot, and that shape was wholly indifferent. Harris, on the contrary, maintained that tube conductors were just as good as solid rods, and that flattened ribbon was better still. Each is reported to have said that the other knew nothing at all about the matter. Of course we know that Faraday was thinking of nothing but conduction, and conduction for steady currents. Harris had probably no theoretical reason to give, but was guided either by instinct or by the result of experience. I think we shall have to admit that, in this particular, Faraday was wrong and Harris was right. The following experiment may serve to illustrate the point further:—

I take two copper conductors of the same length and approximately of the same weight, but one of them in the form of wire, the other in the form of ribbon, and I use them successively as an alternative path. The knobs at A being fixed at two centimetres apart, the B knobs were adjusted until the spark sometimes chose the air gap, and sometimes the alternative conductor. (See Fig. 1 or 2.) The critical B spark length was then:—

	Millimetres.
With the wire as alternative path	8·36
With the ribbon ,, ,, ...	6·26
,, wire ,, ,, ...	8·45
,, ribbon ,, ,, ...	6·05
,, wire ,, ,, ...	8·21
,, ribbon ,, ,, ...	6·06

Very distinctly showing the advantage of a flattened form of conductor over a mere round section.

The dimensions of the two conductors here compared are as follows:—Wire: No. 12 B.W.G., 218 centimetres long, weight 91·6 grammes. Ribbon: 218 centimetres long and 6·4 centimetres broad, weight 88·7 grammes.

But, it may be said, have not experiments often been made as to the advantage of tape over rod forms of lightning conductor, with negative results? Yes, but the point usually attended to is the deflagration of the conductor. Mr. Preece, for instance, with Dr. De la Rue's battery, found ribbon and wire equally easy to deflagrate by the discharge. But we are not examining which form of conductor is least liable to be destroyed by a flash—probably there is not much to choose between one form of section and another, for there is no time for surface cooling—we are examining which form will carry off a charge most easily, and with least liability to side-flash; and here thin ribbon shows distinct advantage over round rod.

Iron *v.* Copper.

You remember we have found that a rod of iron carries off a discharge more satisfactorily than a rod of copper. It would seem as if the poorer conducting qualities of iron enabled the discharge to penetrate deeper, and so to make use of a greater thickness of skin.

But everyone will say—and I should have said before trying—surely iron has far more self-induction than copper. A current going through iron has to magnetise it in concentric cylinders, and this takes time. But experiment declares against this view for the case of Leyden jar discharges. Iron is experimentally better than copper. It would seem, then, that

the flash is too quick to magnetise the iron; or else the current confines itself so entirely to the outer skin that there is nothing to magnetise. A tubular current would magnetise nothing inside it. Somehow or other, the peculiar properties of iron, due to its great magnetic permeability, disappear.

I do not believe anyone could have expected this result. Possibly Lord Rayleigh might have predicted it, and perhaps Mr. Oliver Heaviside. It would scarcely become me to express admiration for the work of so great a master of science as Lord Rayleigh (though, parenthetically, I may mention that I feel such admiration in the highest degree), but I must take the opportunity to remark what a singular insight into the intricacies of the subject, and what a masterly grasp of a most difficult theory, are to be found among the eccentric, and in some respects repellent, writings of Mr. Oliver Heaviside. I cannot pretend to have done more than skim these writings, however, for I find Lord Rayleigh's papers, in so far as they cover the same ground, so much pleasanter and easier to read; though, indeed, they are none of the easiest.

Can this suggestion with regard to iron be examined and verified or disproved, in some other more direct way?

It is easy to try another experiment. I have here two conductors made of tinfoil; each is made of a long slip of tinfoil, about three inches broad, and 21 feet long. One is zigzagged backwards and forwards, with the interposition of three thicknesses of paraffin paper between each zigzag to secure insulation, so as to abolish self-induction as far as possible. This I call the tinfoil zigzag. The other is coiled spirally on a glass tube—again with the interposition of paraffin paper—so as to give as much self-induction as possible. This I call the tinfoil spiral. A bundle of fine iron wires—the core of an induction coil, in fact—can be introduced into this glass tube, or withdrawn, at pleasure. The resistances of these conductors, measured in the ordinary way, are:—·614 ohms for the spiral, and ·708 ohms for the zigzag. They were intended to be alike.

The connections being made as in Fig. 1, one or other of these tinfoil conductors is used as the alternative path L, with this result:—

The length of the A spark being 7·3, the critical spark length at B, when sparks sometimes passed and sometimes failed, was 11·1 when no alternative path was provided. When the tinfoil zigzag connected the outsides of the jars instead of the wire, L, it was not possible to get a B spark till the distance was shortened to 0·6; when this was replaced by the tinfoil spiral, the critical B spark length rose to 6·4. The iron bundle was now inserted in the spiral, and the experiment tried again. The B spark length remained 6·4. The iron made no perceptible difference whatever.

Here is a magnetic time-lag raised to an extreme. Professor Ayrton tells me they have noticed the permeability of iron begin to diminish with very quick alternations. Here it is becoming virtually no bigger than that of air. It may be said that the iron fails to get magnetised because of the opposing action of the inverse "Foucault" currents induced in it, just half a period behind the inducing currents. I thought this would be so, of course, with thick rods of iron, but with a bundle of thin wires I felt doubtful. Lord Rayleigh, however, thinks these induced peripheral currents competent to explain magnetic time-lag in every case; and I can have no doubt that he is right. Whatever the explanation, the fact of time-lag in iron is patent. Yet there is something strange about it, for that a steel knitting needle can be magnetised by discharging a Leyden jar round it is mentioned in every text-book, and (what does not necessarily follow) it is certainly true. There are points here requiring further examination.

However, if it turns out to be true that an iron rod does not get magnetised by the passage of a rapidly alternating current, it may be held a natural consequence of the fact that such currents flow mainly in its outer surface; and that such tubular currents have no magnetising power on anything inside them.

The magnetisability of iron is no objection to its employment in lightning conductors. Its inferior conductivity is an advantage in rendering the flash slower, and therefore less explosive. Its high melting point and cheapness are obvious advantages. It is almost as permanent as copper, at least when galvanised; and it is not likely to be stolen. I regard the use of copper for lightning conductors as doomed.

Experiment of the Bye-path.

We have seen that a conductor is more efficient in carrying off a discharge and preventing side-flash, in proportion as its self-induction is lessened; say by spreading it out into a thin sheet, or cutting it up into a number of wires, or otherwise. But no conductor is able to prevent side-flash altogether,

unless it is zigzagged to and fro so as to have practically no self-induction; in that case the side-spark is nearly stopped. But so long as a conductor is straight (and a lightning conductor must of course be straight), so long will there be some tendency to side-flash, however thick it be made. It may be a foot or a yard thick, and yet not stop it.

One may easily try the following experiment. Take a yard of stout brass or copper rod an inch thick, arrange it in the path of a Leyden jar discharge, and then arrange, as a sort of bye-path or tapping circuit, some very fine wire, such as Wollaston platinum wire. (Fig. 3). It may seem absurd for any portion

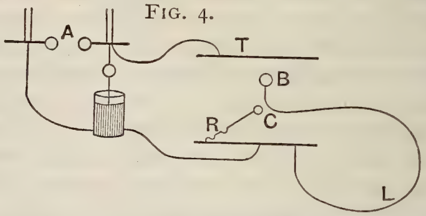
FIG. 3.

of the discharge to leave the massive rod and take the hair-like wire by preference, especially if an air-gap exists at A or at B, or at both. Nevertheless a portion *does* choose the fine wire path, and you get a little spark at A or at B about a sixteenth of an inch long. One may vary the experiment by trying to get a shock by holding two different parts of a thick copper rod through which a discharge is passing. The mere difference of potential between conductor and earth must of course be avoided. It is not easy to get an appreciable shock from a few yards of very stout conductor; still it can be done. Holding two points of a stout open spiral, consisting of about five yards of No. 1 copper wire, connected to earth, a faint shock can be felt with wetted hands whenever a Leyden jar is discharged through the copper. No doubt with a very large condenser the shock would be quite noticeable; and a man touching a lightning conductor, however well earthed, might perhaps receive a shock sufficient to kill him. At all events, I should not care to try the experiment with a real lightning flash.

EXPERIMENT OF THE SIDE-FLASH.

Let me illustrate the tendency to side flash by a more directly applicable looking experiment. Fig. 4 shows a couple of tin-plates or tea-trays fixed a foot or so apart, one earthed, the other insulated. They obviously represent, one a charged cloud, the other a layer of thoroughly good conducting earth. A lightning conductor, B L, is provided; L consisting of a considerable length of stout copper wire or rod. At C a possible side path is provided so that, if the flash chooses, some of it can spit off through an inch or so of air, and through an interposed resistance, R, to earth. A side flash, C, is found to occur unless the sparking distance is made too great; and the effect of ncreasing R is not to stop the side flash, but to weaken it. Thus, even with the liquid resistance of nearly a megohm at R, an inch spark still passes at C for every flash at B, though the C spark is now very weak.

FIG. 4.



How can this tendency to side flash be further diminished? At the end of the last lecture I hinted at a partial remedy—elasticity. To stop a pipe full of water from being burst by a blow given to the water, you will make the pipe elastic. An elastic cushion will ease off the violence of the shock of a water-ram.

Electric inertia was known by the other name of self-induction; electric "elasticity" is known by the other name of capacity. Increase the capacity—not the thickness or conducting power, but the electrostatic capacity of your conductor—and it will be able to carry off more.

This phrase, "the capacity of a conductor," when used by the old electricians, commonly signified merely its conducting power, this being the sole thing most of them thought of; but using it in its modern signification, let us see what advantage is to be gained by increasing the capacity of a conductor—say, by connecting to its two ends the coatings of a Leyden jar.

Take the No. 18 wire round the room and use it as an alternative path, as in Fig. 1, first without a jar connected to its ends, then with a jar. Length of spark at A, 5·35 tenths of an inch; corresponding critical B spark-length:—

Iron wire without jar, 6·5;
Iron wire with jar, 5·0.

Not a very great difference. Not so great a difference as would be gained by diminishing the self-induction by flattening the wire out into foil. Still it is in the right direction, and we see what we have to do:

diminish self-induction as far as possible, and increase capacity whenever convenient. One may also try the experiment by attaching a jar to the conductor B, in Fig. 4: the side flash, C, is somewhat shortened.

But of an actual lightning conductor how is it possible to increase the capacity? There is no sense in surrounding it with an earth tube, because that, after all, would only act as an additional conductor, and might as well be so considered from the first. Neither does a great series of polarisable voltameter plates seem a feasible suggestion. No; the only practicable plan is to expand it over as much surface as possible. A lead roof, for instance, affords an expansion of fair capacity which may be easily utilised; and there should be as little mere rod projection as possible before some extent of surface begins. Flat sheet for chimneys is better than round rod—it has at least *some* more capacity and much less self-induction.

For tall isolated chimneys I would suggest a collar of sheet metal round the top, and at intervals all the way down; or a warp of several thin wires instead of a single rod, joined together round the chimney by an occasional woof; or any other plan for increasing capacity and area of surface as much as possible.

Liability of Objects to be Struck.

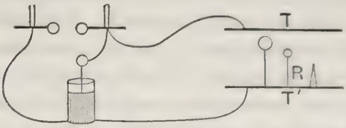
Now try experiments on the liability of things to be struck. Is a small knob at a low elevation as liable to be struck as a large surface at a higher elevation? Is a badly conducting body as liable to be struck as a well conducting one? In other popular words, does a good conductor "attract lightning?"

In answering this question experimentally, we must draw a careful distinction between the case of a flash occurring from an already charged surface, which has strained the air close to bursting point before any flash occurs, and the case of a flash produced by a rush of electricity into a previously uncharged conductor too hastily for it to prepare any carefully chosen path by induction. The two cases are—1st. Steady strain; 2nd. Impulsive rush. Take them separately.

First with Steady Strain.

First an experiment on the liability of things to be struck when the air above them is in a state of steady strain gradually increased. I take the two tin plates arranged one over the other, and stand between them three conductors, one ending in a large knob, a second ending in a small knob, and the third ending in a point (Fig. 5).

Fig. 5.



The experiment consists in working up the charge of a jar attached to the top plate until discharge occurs, and in adjusting the three conductors so that they may be indiscriminately struck. One finds that the point, even when very low, prevents discharge altogether. It may indeed be too low to be effective; or again it may be insufficient to cope with the supply of electricity; but we see here the well-known function of a point—prevention of discharge Remove or cover up the point now, and attend only to the large and small knobs. If the knobs are negative and the plate above them positive, brush discharge goes on from the knobs, and it is not easy to get a long flash; but by reversing the connections the tendency to brush is greatly lessened, and we now get flashes some three or four inches long. But always to the small knob. The small knob has to be pulled down about three times as far from the charged surface as the big knob is, before it ceases to protect the big knob; and the latter is then for the first time struck. This occurred, for instance, when the distance of the big knob from the top plate was 9, and the distance of the small one $29\frac{1}{2}$ (tenths of an inch). They were then either of them struck indiscriminately. If the little knob was any taller than $29\frac{1}{2}$, it alone was struck.

Now what is the effect of resistance upon the protecting power of the point or small knob? Scarcely any. Instead of connecting the small knob direct to the bottom tray, connect it through the liquid megohm, R, and it gets struck just as easily as before.

Here are distance readings when they get struck with equal ease:—Large knob distance, 7·5; small knob distance, with high resistance, 22·0. The point protects both up to distance 60·0, until covered up by a thimble.

Thus the flash actually prefers to jump three times as much air, and encounter a megohm resistance, rather than take the short direct path offered by the bigger knob. The sizes of the knobs in this experiment are:—1·27 inch diameter for big knob, and ·56 inch for small knob.

Of course, the cause of this is well known. It is merely that the air breaks down at the weakest point, viz., on the surface of one of the knobs, and the tension on the small knob is much greater than that on the big one, for a given difference of potential. The fact that the discharge begins in the air above the conductor explains why it is that adding resistance—even enormous resistance—to a conductor makes no difference to the length of the spark which strikes it. The path is prepared inductively in the air, and the resistance of the path which the discharge must ultimately take makes no difference, provided it is not so nearly infinite as to prevent the free adjustment of the static charges and inductions set up as the machine is worked. But though high resistance makes no difference to the length of the spark, it does affect its noise and violence. The discharge striking the small knob has now only a soft velvety noise. Its energy, or heating effect, is much the same, but its suddenness, and, therefore, its noise and violence, are enormously lessened.

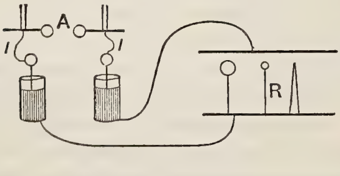
This water resistance is equivalent to a shocking bad earth; and its effect is, we see, to make the spark gentle. But it is an evident advantage to have a discharge take this quiet and managable form. The worse a conductor is, the quieter will be the flash, and, up to a certain limit, it will protect just as well apparently. Hence, surely, a bad earth is an advantage. But wait a bit; we have not yet considered the other case—the impulsive rush.

Second, with Impulsive Rush.

Let us now modify the experiment to try the second form of the experiment—the impulsive rush.

Fig. 6 shows the connections. There is no difference of potential between the trays up to the very instant of discharge. The jars

Fig. 6.



gradually charge up (they stand on the same wooden table), and ultimately discharge at A; a violent rush then takes place into the two plates, and the conductors between are struck. Adjust them till they are all struck with equal ease, as before; we find the conditions utterly different. No longer does the small knob protect the taller big knob; no longer does the point exert any special protective influence. All three bodies—large knob, small knob, point—are equally liable to be struck if at the same height, and no one is more liable than another; simply the highest is struck if they are at all equally conducting. It is easy to get all three struck at once. *Now* make one bad conducting, and its protective virtue is gone. Putting the liquid megohm into any one of the three conductors, and that one is no longer struck. It ceases to protect the other two even if taller than they; nay, even if it be raised so as to *touch* the top tray, thus establishing direct conducting communication of a poor kind between cloud and earth, still next to none of the flash chooses that path, and the other two conductors get struck with apparently just the same ease as before. This is the real objection to a bad earth; it cannot protect well against these sudden rushes.

Sudden rushes are liable to occur; the clouds spark first into one another, and then, as a sort of secondary effort or back kick, into the earth. For instance, two clouds one above the other; the top cloud sparks into the lower, and this at once overflows to the earth. In these cases the best conducting and highest objects are struck, quite irrespective of any question of points and knobs. Points are no safeguard against these flashes, as you see. The point gets struck by a vivid flash, exactly of the same character as that which strikes one of the knobs; it has no time to give brushes or glows; its special efficacy in preventing discharge exists only in the case of steady action, where the path is pre-arranged by induction. In the case of these sudden rushes, the conditions determining the path of discharge are entirely different. No doubt they have to do with what is called the "time-constant" of the various conductors.

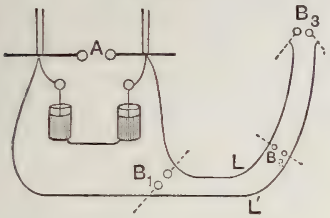
Experiment of the Recoil Kick.

It will have been noticed that in the experiment of Fig. 1, the spark obtained at B is longer than the spark at A. And the question arises why this should be so. Plainly what is happening is this: the discharge at A sets up electrical oscillations, and the charge of the jars is rapidly reversed. The difference of potentials of the inner coats changes from, say, +V to nearly —V, and back again; the difference of potential of the outer coats changes therefore from 0 to nearly 2V, and

hence the B spark may be expected to be nearly twice as long as the A spark; and so it is.

These electrical oscillations are of considerable interest, and have sundry practical bearings; let us proceed to make them more conspicuous. Fig. 7 shows a couple of long leads,

FIG. 7.



L and L′, reaching round the room (No. 18 wire in two 95-feet lengths was actually employed), insulated from one another and from the earth, but attached to the two poles of a machine; the machine having also a couple of Leyden jars attached to it in the customary manner when supplied by the maker. A discharger, B, can be arranged to bridge the gap between these leads, either near the machine, as B, or about the middle, as B_2, or at the far end, as B_3. Now, of course, sparks can be obtained either at A or at any of the B knobs, and all about the same length; but supposing the A knobs to be brought nearer than the B knobs, the spark would be expected to occur at A only. Nevertheless, on trying the experiment, one finds that every time a spark occurs at A, a longer spark occurs at B; it is, as it were, precipitated with a rush; and the longest spark of all is obtainable at the far end, viz., at B_3.

Here are some figures, in the obtaining of which, however, for convenience of manipulation, the B length remained constant in each position, and the least length of the determining spark, A, was the thing observed:—

Nearest position	Spark length, A	3·20	4·15	5·12
	Corresponding spark length, B_1	3·22	4·80	6·18
Middle position	Spark length, A	1·92	2·37	2·70
	Corresponding spark length, B_2	3·22	4·80	6·18
Furthest position	Spark length, A	1·60	2·2	2·45
	Corresponding spark length, B_3	3·22	4·80	6·18

The electricity in the long wires is surging to and fro, like water in a bath when it has been tilted; and the long spark at the far end of the wires is due to the recoil impulse or kick at the reflexion of the wave. Evidently there are some quantitative relations to be specified here, and there will be some best capacity of the jars corresponding to a given length of conductor, and to a given arrangement of main discharge circuit, A. The nearer the length of the conductors corresponds to a half-wave length, or some multiple of a half-wave length, of the oscillations produced by the discharging jars, the more perfect will be the synchronism between the pulses, and a longer recoil kick may be expected. The arrangement may in fact be compared to a resonant tube excited by a tuning fork or reed, to Melde's experiment with vibrating strings, or to any other case of forced vibration.

The following numbers will just serve to show some difference of effect caused by different sizes of jars. Using two pint jars in series, and fixing the A spark at 4·5, the B_3 spark at the far end just ceases when the knobs are pulled out to 7·8. But, replacing the pint jars by gallon jars, the B_3 spark does not cease till the knobs are separated to 10·9; the corresponding spark in the position B_1 being only a trifle longer than the A spark, viz., 4·7.

It is not to be supposed, however, that by increasing the capacity of the jars still farther, a still better effect will be obtained; for on replacing the two gallon jars by the very large condenser of alternate glass and tinfoil sheets, we find the spark at B_3 fails when the knobs are only 5·9 tenths of an inch apart: the length of the A spark remaining 4·5, as before.

There is, as I say, a quantitative relation; and it is a relation which the modern theory of electricity makes known. I cannot go into it here, but I may just say that, very approximately, the wave-length of the electrical oscillation of a discharging jar is 2π times the geometric mean of the static capacity of the jar and the electro-magnetic inertia of the discharger.

The capacity of the two gallon jars in series (this being the capacity which gave the

best result with 95 feet of leads) was about ·002 microfarad, or, say, 1,800 centimetres; hence, supposing the wave length of their discharge through the A knobs to be something like 190 or 200 feet (twice the length of the leads), we should calculate the self-induction of the circuit formed by the jars, short connecting wires, and A knobs, as something like five metres, which is a reasonable enough value.*

Repeating the experiment (Fig. 7) with the two gallon jars in series, but insulated this time from the earth, a still longer spark at B_3, the far ends of the long wires, can be obtained; viz., $A = 4·5$, $B_3 = 14$; and even when the knobs of the discharger are separated beyond this distance, a brush still passes between them for every spark at A.

Removing the discharger altogether, and making the experiment in the dark, a very interesting effect is seen; the further end of each wire glows with a vivid brush light; showing the exceedingly high potential to which they are raised by the recoil. I do not see the effect with thick No. 1 wires, but with No. 18 wires it is very marked. The glow on each of the two wires is independent of the position of the other; thus, if the connexions are made so that the wires run opposite ways right round the room from the machine, the distant end being insulated, it is still the end of each furthest from the machine that glows, although they are separated from one another, for most of their length, by the whole width of the room. With the two gallon-jars the wires glow over fully three-fifths of their entire length. With jars of much larger or much smaller capacity the length of glow is conspicuously less.

Connect a small pint jar to the ends of the wires, and all these effects cease. The increase of static capacity reduces their potential below the brushing point. Arranging the jar so as to leave an air space between it and one of the wires, a spark passes into it at each A spark; but the jar is not the least charged afterwards—proving that the spark is a double one, first in and then out of the jar, a real recoil of a reflected pulse; hence it is also that the appearance of the brush is the same on the two wires, one is not able to say which is the positive and which the negative wire, for each is both.

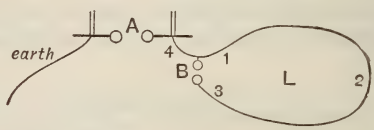
* Since the delivery of the lecture, a great number of quantitative observations on these lines have been made. Evidence of electro-magnetic waves 30 yards long has been obtained. I expect to get them still shorter.

EXPERIMENT OF THE SURGING CIRCUIT.

What seemed to me, when I first made it, a curious illustration of these electrical surgings or oscillations going on in a conductor which is being suddenly discharged at one end, is afforded by the following extremely simple experiment.

Attach one end of a long insulated wire to the machine, and connect the other pole of the machine to earth. Jars connected up also to the machine do no harm, but they are unnecessary. The wire now practically constitutes one coating of a condenser, of which the walls of the room are the outer coat. The wire is made to form a nearly closed circuit, and its further end brought within an inch or so of the near end, as at B. (Fig. 8).

FIG. 8.



Under these circumstances one would at first sight say that a spark at B was absurd, for the two knobs are metallically connected through a stout conductor, which may be No. 1 wire, and not necessarily many yards long. Nevertheless, it will be found that sparks at B can be obtained quite as long, though not quite as strong, as those at A. Every A spark is accompanied by a B spark, unless, of course, the knobs are too far separated.

One may surmise that it is the static charge on the distant portion of the conductor which, having to rush toward A, prefers the short path, B, instead of the longer path *viâ* the wire. But this is not the whole account of the matter, as can be shown by interposing high resistance in the conductor at various points; say at the places 1, 2, 3, or 4 (Fig. 8). Introducing a quarter of a megohm at the point 1 or at 3 weakens the B spark very much, and apparently about the same whether it be at 1 or at 3; the strength (*i.e.*, the noise and appearance) of the A spark remaining much the same. Introducing a high resistance at the point 4 weakens both the A and the B sparks. Introducing a high resistance at the point 2 leaves both sparks pretty much as strong as they were were without it.

The spark at B is caused by electrical oscillation—a surging of the charge of the wire

to and fro like water in a pipe. One might liken it to an elastic pipe pumped very full of water, and its end closed with spring valves. If, then, one end is suddenly opened and shut, a pulse is transmitted through the pipe, which may force open the valve at the far end and let some water escape.

It is these electrical oscillations, I doubt not which account for the long spark obtained by the use of a "Winter's ring."

This last experiment, Fig. 8, however it may be explained, has an obvious application to the question of connecting roof gutters to lightning conductors. It is most desirable to connect them, but both ends should be connected. If only one is connected, the far end is very likely to spit off a flash.

Again, we see how, when a flash strikes a system, the electricity goes rushing and swinging about everywhere for no apparent reason, just as water might surge about in a bath or system of canals into which a mass of rock had just dropped, splashing and overflowing its banks. Just so with electricity. Bell-wires, gas-pipes, roof-gutters, conduct side-flashes in a way most puzzling to the older electricians; and thus gas may get ignited in the most unexpected places, and passengers in a train may feel a shock because a charge has struck the rails. In powder magazines it is apparent how dangerous this lawless sparking tendency may be; for even the hinge of a door may furnish opportunity for some trivial spark sufficient to ignite powder. By no means, it seems to me, should high rods be stuck up to invite a flash to such places. Build them, or line them, with connected iron, barb them all over the roof, connect them to the deep ground in many places, and I don't see what more can be done.

Experiments on Overflow of Jar.

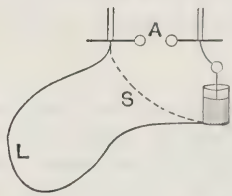
Another way of making these electrical surgings more conspicuous is by their effect in causing a jar to overflow *i.e.*, to spark round its edge. The overflow of a common jar is in fact very like a lightning flash, for it is a discharge direct between two coatings. That is just what a lightning flash is. There is ordinarily no conductor present except the two coatings—the clouds and the earth. I found a curious remark in Franklin* about the overflow or fracture of Leyden jars. He found that when one broke from overcharging, a great number went together; *and also that the spark in the ordinary circuit did not fail.* He was led by this observation to doubt if the breakage of the jar was really due to a discharge of the electricity through it, and he surmises that it may be due to a sudden expansion of air bubbles in the interior, suddenly relieved of the strain.

* "Franklin's Works," by Sparks, 1840. Vol. v., page 475.

No doubt he is wrong there, but the observation of the facts is good and noteworthy. We will repeat the experiment. It is not necessary to burst the jars; overflow round the edge is just as good, and cheaper. The overflow experiment can be put into a variety of forms; perhaps it will be sufficient if I show the simplest.

Fig. 9 shows the arrangement. It consists in nothing but establishing the connection between the machine and one or both of the coatings of a jar, through a long wire instead of through a short one as usual. If one con-

Fig. 9.



nects the jar C by the dotted line, it does not overflow until the spark-length A is very great; but with a long lead L to make the connection, a very short spark at A will cause the jar to overflow or discharge round its edge.

Here are a few numbers. The jar is one of the gallon jars, with the glass fully three inches above the tinfoil, so that, when it overflows, the spark has to strike along fully six inches of glass. When L is the thick No. 1 copper circuit round the room the jar overflows every time an A spark occurs, even though the length of this A spark is only ·64 of an inch. Short circuit out the long lead, as shown by the dotted line, and the jar refuses to overflow until the A spark-length has been increased to 1·7; and when it does overflow now the violence is very considerable. Remove short circuit again, and the jar overflows in ever so many places at once with great violence, a perfect cascade of flashes leaping round the edge. Bring the A knobs nearer together, and the overflow does not wholly cease till their distance apart is again ·62.

On another occasion one got, for the A

spark-length sufficient to cause overflow of jar:—

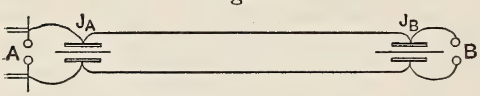
·56 with the long lead.
1·7 with an ordinary short wire.

With a small pint jar, and a less height of glass above its coatings, I took the following readings:—Length of A spark sufficient to cause overflow—

·67 with iron wire round room.
·52 with copper ,,
1·40 with short circuit.

Fig. 10 shows very well, in a diagrammatic fashion, the effect of long leads in causing a jar to overflow, or of course to burst if the glass edges are too tall for the thickness and homogeneity of the glass to stand.

Fig. 10



A are the machine terminals, B those of a discharger, and J_A and J_B are two jars connected up by fairly long leads. Now of course sparks may be obtained either at A or at B, one as easily as the other, and one of the jars is liable to overflow, but not both. It is the jar J_B which overflows when a spark occurs at A. It is the jar J_A which is made to overflow by a spark at B. It might be thought that if the B knobs were fairly near together, a spark at A might precipitate a spark at B instead of making J_B overflow; but it is not so. The event is not indeed impossible by any means, if the B knobs are pretty near together; but it is easier for the jar to overflow by direct discharge between its coatings over a space of some six inches, than it is for it to discharge through the wire and rods of the discharger and an air-space of an inch or even less. It is not easy to help a jar to overflow by discharging tongs; even a foot of conducting wire is a great obstruction to the passage of the flash; it greatly prefers direct discharge through air unobstructed by the self-induction confinement of a conductor.

This is also illustrated by the extraordinary length of insulating surface which is found necessary in the Leyden jars supplied to Holtz and other such machines, and by the fact that such jars often flash even over a foot instead of through a few inches of air space led up to by the proper discharging knobs. Though indeed it must be noticed, as it was by Franklin, that the overflow of a jar by no means necessarily robs the proper circuit of its flash. The two things occur together. It is usually the spark which causes the overflow. Perhaps one may say that the case of discharge direct between coatings without any conductor, accounts in some measure for the extraordinary length and unexpected paths of some lightning flashes.

These electrical oscillations and overflows, which it is thus easy to set up in a charged conductor, manifestly explain what is known as the "return stroke." I pointed out in Lecture 1 that the ordinary explanation of the return stroke, the recovery of electrical equillibrium disturbed by static induction, was by no means able to account for effects of the least violence; but this fact, that a discharge from any one point of a conductor may cause such a disturbance and surging as to precipitate a much longer flash from a distant part of it, at once accounts for any "return stroke" that has ever been observed.

It is for this reason that I think it possible a tall chimney or other protuberance in one's neighbourhood may be a source of mild danger; inasmuch as if it is struck it may be the means of splashing out some more discharges to other smaller prominences, which otherwise were beyond striking distance. It is in this way, also, that I imagine multiple flashes, such as those referred to in Lecture 1, are produced. I liken them to the cascade of flashes rushing over the sides of a jar, when connected up with a long lead, and when the A spark is pretty long.

Experiment of the Gauze-house.

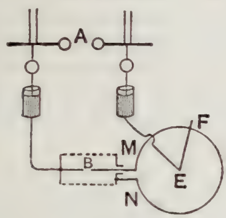
Finally, we have to ask is it possible for the interior of a thoroughly enclosed metal room to be struck; or, rather, can a small fraction of a lightning flash find its way into a perfectly enclosed metal cavity; for instance, a spark strong enough to ignite some gun-cotton in a metal-covered magazine which might happen to be struck?

It is not easy, but it can be done; at least under such conditions as are likely to obtain in practice it can be done. My friend Mr. Chattock, to whom I am indebted for much kindly assistance and suggestion, has made the experiment in the form shown in Fig. 11.

A metal gauze cylinder, with tinplate

ends, has a couple of conductors, one soldered to each end, protruding into the interior, so as to approach very near each other, and these are the conductors put into the path of the discharge. If both conductors are entirely enclosed in the metal chamber, we have not yet succeeded in getting a spark between them; but if either of them protrude any portion of their length outside the chamber, then sparks in the chamber can be obtained.

FIG. 11.



In Fig. 11 the conductor N M B is shown thus protruding, penetrating the chamber through a small glass tube near M, but soldered to it near N. E F is a movable arm or radius, making contact with this conductor. If contact is made near M, it takes a very strong A spark to give any spark at B inside the gauze cylinder; but as the contact from F is shifted towards N, it becomes very easy to get a small spark at B.

The application of this to powder magazines is that if any conductor (like a gas-pipe) pass out of the building before being thoroughly connected with its walls, it is possible for a spark to pass from something in the interior of the building to this conductor whenever a flash strikes the building. We thus find that the complete and certain protection of buildings from lightning is by no means so easy a matter as the older electricians thought it.

In many cases we may be content to fail of absolute security and be satisfied with the probable safeguard of a common galvanized iron rod or rope. But for tall and important buildings, for isolated chimneys and steeples, and for powder magazines, where the very best arrangement is desirable, what is one to recommend? I prefer to call attention to principles rather than to advocate any particular nostrum; but inasmuch as my present opinion is not likely to carry any undue weight, there is no harm in my saying that I see nothing better than a number of lengths of common telegraph wire. I think a number of thin wires far preferable to a single thick one; and their capacity must be increased when possible by connecting up large metallic masses, such as lead roofs and the like. But the connection should be thorough, and made at many points, or sparks may result. Balconies, and other prominent and accessible places, should not be connected.

The earth should be deep enough to avoid damage to surface-soil, foundations, and gas and water mains. As to the roof, I would run barbed wire all round its eaves and ridges, so as to expose innumerable points, and the highest parts of the building must be specially protected; but I would run no rods up above the highest point of the building, so as to precipitate flashes which else might not occur, in search for a delusive area of protection which has no existence.

The conductors must not be so thin as to be melted or deflagrated by the flash; but really, melting is not a very likely occurrence, and even if it does occur, the house is still protected; the discharge is over by the time the wire has deflagrated. The objection to melting is twofold. First, the red-hot globules of molten metal, which after all are not usually very dangerous out-of-doors; and secondly, the trouble of replacing the wire. I should be content to put up a great number of telegraph wire conductors, and wait till one is melted, before thinking too much of the likelihood of such an occurrence. The few instances ordinarily quoted of damage to lightning conductors by a flash do not turn out very impressive or alarming when analysed.

In conclusion, I trust that the men of experience in these matters who are present will consider the facts and suggestions I have brought forward as objects worthy of attention and further inquiry, and will study them in the light of their experience.* But as to the quack recipes and dogmatic statements which I may incidentally and without authority have provisionally given, there is no need for me to ask practical men to treat these with the contempt they no doubt deserve.

* At the second lecture I learnt that some experiments on lightning protectors, something like those of mine on "the alternative path," had been made previously by Professor Hughes and M. Guillemin (address to telegraph engineers). Also I find that Dr. Hertz has made experiments on electric oscillations very like those of mine on "the surging circuit." (Wied. *Ann.*, 1887). In a subsequent communication I hope to notice some of the observations of Professor Hughes.

Miscellaneous.

ANIMAL FOODSTUFFS OF HONDURAS.

European domestic cattle are raised in considerable numbers, so that there is little occasion to utilize the wild native animals as food. Nevertheless, the Indians subsist largely on the flesh of two kinds of wild hog or peccary, the common or collared peccary (*Dicotyles tajace* [*torquatus*]), and the white lipped peccary, or *warrel* (*D. labiatus*). Both these species emit a highly offensive odour from a small gland in the back, and this spot is always cut out immediately the animal is killed, to prevent the meat becoming tainted. The flesh is cured by drying it in the sun, forming what is known as "barbecued pork." The tapir affords coarse, dry meat of a somewhat beef-like flavour, esteemed by the Indians. Other wild animals are the anteater, armadillo, cony, red deer, gibonet, iguana, quash, and squirrel. Alligators and manatees occur in the lagoons. Turtle catching is quite an industry, the green turtle being in most request for food, while the hawksbill and loggerhead are more esteemed for their shells. Several river tortoises are caught for eating, the best being the *hiccatee*. The flesh of some of the conches is used as food, but their shells are neglected. The most esteemed fish are the *caliipeva* or Jamaica salmon (*Mugil liza*), the snapper, the bass, the mountain mullet or tropical trout (*Mugil* [*Dajaus*] *monticola*), a delicate white-fleshed fish, affording excellent sport to the angler; also the grooper, and king or june fish. Game birds include wild turkeys, ducks, partridges, and pigeons.

BRUSSELS EXHIBITION.—BRITISH SECTION.

The severe weather at the beginning of the year had the effect of retarding by about a month the opening of the Brussels Exhibition, which took place on June 7th. The grounds were, however, thrown open to the public previously, and tram-cars, both horse and electric, run quite up to the main building, those by the Rue de la Loi on the left, and those by the Rue Beliard on the right.

On Saturday, 19th ult., the British Section was inaugurated by Lord Vivian, her Britannic Majesty's Minister Plenipotentiary and *Chargé d'Affaires* at the Court of Brussels.

Among the objects in the British Section may be mentioned the "Frazer" type-composing and distributing machine, by the aid of which a considerable portion of the "Encyclopædia Britannica" has been set up; Harrington's Tube Bells; Fox's corrugated boiler flues, flanged locomotive frames, and corrugated wheel tires for permitting vehicles to pass over the grooves of tramway rails without becoming engaged in them; and the plans of the Railway Train Telegraph Company, illustrating their method of telegraphing to and from trains in motion.

Messrs. Pickford, Smith, and Co. show their fuses for simultaneously firing any number of mine charges, and also their colliery fuse for igniting the blasting charge in fiery mines, without exposing any spark or flame to the surrounding atmosphere. The Great Eastern Railway Company exhibit a model of their last and largest steamer, the *Cambridge*, which is electrically lighted throughout; and Mr. Benjamin Edgington has sent a specimen of his patent trestle cot and hammock for travellers, and models of the tents supplied to Mr. H. M. Stanley for the Emin Pasha Relief Expedition.

Most of the new and economic gas burners are represented, including the Incandescent, the Wenham, and the Fourness, together with Lidstone and Co.'s permanent stone wicks for petroleum and other lamps; while a practical illustration is given outside the Annexe of the Doty lamp, which is fed with heavy mineral oils.

In the grounds a circular undulating railway, the cars on which are moved by compressed air, has been designed and laid down by Messrs. Gill and Hartley.

Correspondence.

THE ROYAL SOCIETY AND THE SOCIETY OF ARTS.

In the "History of the Royal Society," by Thos. Sprat, D.D., the several editions show that the original design of the society was particularly devoted to the promotion of the national industry. Indeed, the development of trade, and what is now termed technical education, are prominently brought forward.

The development of the colonies was embraced in this design, and there is a particular reference to Virginia. "Virginia has already given silk for the clothing of our king." (Chas. II., circ. 1666.)

When towards the middle of the eighteenth century the Royal Society had abandoned this part of its original functions, the Society of Arts was founded on a similar basis of public utility, and has continued successfully to carry out objects to which the Royal Society no longer devoted itself.

HYDE CLARKE.

Journal of the Society of Arts.

No. 1,858. Vol. XXXVI.

FRIDAY, JUNE 29, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 27th instant, at 4 p.m., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Chairman of the Council, in the Chair.

The Secretary read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, ballotted for, and duly elected members of the Society:—

Ablett, Thomas Robert, 36, Wemyss-road, Blackheath, S.E.
Agg-Gardner, James T., M.P., Cheltenham, and Carlton Club, S.W.
Bass, Hamar A., M.P., 145, Piccadilly, W.
Bellew, Surgeon-General Henry Walter, 83, Linden-gardens, Bayswater, W.
Berg, William, 37, Mincing-lane, E.C.
Binney, William, Hillfield, Hampstead, N.W.
Cotton, Henry Morten, 8, Eccleston-square, S.W.
Davenport, Henry, Woodcroft, Leek, Staffordshire.
Davies, Major Horatio David (Sheriff of London and Middlesex), Strode-park, Herne, Kent.
Fleay, Frederick Gard, M.A., 33, Avondale-square, S.E.
Forbes, Urquhart Atwell, 1, Brick-court, Temple, E.C.
Francis, Arthur Henry Martin, 17, Mowbray-road, Brondesbury, N.W.
Joseph, D. Davis, 2, Gwydir-gardens, Swansea, South Wales.
Kerr, General Lord Mark, K.C.B., 4, James-street, Buckingham-gate, S.W.
Macfarlane, Hugh, 63, Old Dumbarton-road, Glasgow.
Noble, Wilson, M.P., Carlton-club, S.W.
North, Colonel John T., 3, Gracechurch-street, E.C.
Phillips, George C., The Limes, Grove-road, Chelmsford.
Saner, J. A., Highfields, Northwich, Cheshire.
Sidebotham, James Nasmyth, Erlesdene, Bowdon, Cheshire.
Smith, S. S., The Crichtons, Romford, Essex.
Townsend, Thomas Charles, 22, Halford-road, Richmond, Surrey.
Walford, Major Neville L., R.A., 66, Lowndes-square, S.W.
Watson, Joseph Spencer C., Beckingham, Gainsborough, Yorks.

The Chairman nominated Mr. R. Bannister and Rear-Admiral Buckle scrutineers, and declared the ballot open.

The Secretary then read the following:—

ANNUAL REPORT.

I.—Ordinary Meetings.

As usual, the Session was opened by an address from the Chairman of Council. Sir Douglas Galton selected as his principal topics, Education and Sanitation, and dwelt on the useful work which has been performed by the Society of Arts in these two important departments of human progress.

In addition to the opening meeting, there have been twenty meetings at which papers have been read. The papers generally were of a very high average, and, as in former years, included a very great variety of subjects. The first paper of the Session, by Professor Silvanus Thompson, on the "Mercurial Air Pump," gave a very complete history of the various modifications which have been made in the apparatus since its first invention down to its recent development and practical application for the exhaustion of incandescent electric lamps. Another paper in which an important advance was chronicled in the construction of scientific apparatus was that read by Sir Howard Grubb, at a later period of the Session, on "Telescopes for Stellar Photography." Recent advances in photography have made it possible to produce maps of the sidereal heavens on a scale which had never been contemplated until within recent years, and the possibility of producing such maps has rendered necessary the

construction of apparatus which will keep a telescope fixed on a given object with minute accuracy. Most equatorial movements, while sufficient for visual observation, are not accurate enough for photographic purposes, and, up to the present, the adjustment for all stellar photographs has been corrected by hand; the observer keeping his eye at the "finder" of the telescope, and adjusting the apparatus as the star watched shows any tendency to shift from the centre point. Sir Howard Grubb has succeeded in producing an equatorial movement which renders almost, if not entirely, unnecessary this minute adjustment by hand.

During the Session a more than usual number of meetings have been devoted to the important subject of education. Sir Philip Magnus dealt with the department of Commercial Education, and Mr. Swire Smith with that of Technical Education. Both of these papers gave rise to important and interesting discussions, that on Mr. Swire Smith's being continued for a second evening. Another branch of technical education was treated by Professor Wrightson, in his paper on "Agricultural Instruction." Mr. Lant Carpenter showed the importance of continuing elementary education after the earlier school ages; and Mr. Ablett, in his paper on "Drawing as a means of Education," insisted on the importance of instruction in drawing, not only on account of its practical value, but as a useful instrument for cultivating the mind.

The subject of electric lighting, to which so much attention has been given by the Society in recent years, was treated by Mr. R. E. Crompton, who, in his paper on "Electric Lighting from Central Stations," endeavoured to prove that the difficulties inherent to the introduction of the new system of illumination had now been to a very large extent overcome, and that it rested with the owners of house property whether they would or would not introduce into their houses some system of electric lighting. Another method of providing light formed the subject of Mr. Hannay's paper on "Illumination from Waste Oils." In it he described the ingenious apparatus known as the "Lucigen," in which mineral oil is caused, by the use of a blast of steam or air, to produce an enormous flame, very suitable for purposes of out-door illumination.

There were during the Session two papers dealing with sanitary matters, one by Mr. Fletcher on the "Present State of the Law concerning the Pollution of Air and Water," and the other by Mr. Thornton, who dealt with the "Sanitary Evils of Canal Irrigation in India." Miss Chreiman also treated a subject of great importance from a hygienic point of view, "The Physical Culture of Women," a subject to which she is known to have devoted a great deal of attention, and in which, as regards the training of children, she has achieved some important successes.

Mr. Walter Emden's paper on "Theatres and Fireproof Construction" gave an account of some of the most recent devices which have been adopted or proposed for ensuring the safety of the public from the terrible disasters of which we have unfortunately had recently but too frequent examples.

Various methods of taking the ballot formed the subject of three papers read on one evening, by Mr. Leighton, Mr. Withers, and Mr. Imray. Mr. Leighton's suggestion was that the ballot should be taken by post, and he proposed a carefully considered method of accomplishing this object; while Mr. Withers and Mr. Imray described mechanical devices for the purpose of voting. Mr. Harrison, in a paper on "Typewriters and Typewriting," gave a useful account of the valuable invention which has been proposed as a substitute for the pen. Mr. P. L. Simmonds, who has contributed so many important papers to the Society's proceedings, read one upon the "Uses of Eggs." Mr. Schloss brought before the Society his views on "The Sweating System," which has since and is now attracting so much attention in Parliament and elsewhere. Mr. Rowlett gave a useful paper on "Framework Knitting," and described the various ingenious devices which have of late years been introduced. Mr. Samuel Chatwood, a well-known authority on the subject, described the most recent inventions for the improvement of "Locks and Safes," and showed the very great advances which have been made of recent years in withstanding the attacks of the burglar. It seems to be admitted that, as regards fire, what may be considered as absolute security has for some time been attained.

II.—The Indian Section.

Six papers were read before the Indian Section during the Session of 1887 8. At the first meeting, on January 27th, Mr. Justice Cunningham, of the Calcutta High Court, gave an interesting and detailed account

of the state of "Public Health in India," showing what had been done, or left undone, for the sanitary welfare of the country by the Government, and the municipalities who now possess practical control of the matter within their respective areas. Mr. Justice Cunningham's suggestions have already received much attention from the authorities in India, and his paper will long be remembered as a valuable contribution towards the elucidation of an important and difficult question. At the second meeting of the Section, on February 10th, Captain Manifold, lately attached to the Indian Intelligence Department, read a paper on "The Work of the Afghan Frontier Commission," in which he gave a concise summary of the geographical, historical, and general results achieved by the labours of Sir Peter Lumsden and his successor, Sir West Ridgeway, assisted by the efforts of a small body of Royal Engineer officers, of whom Major Holdich was the chief. The third meeting was held on February 24th, when Sir William Hunter gave an address on "Statistics regarding the Religions of India, and their Influences on the Moral Progress of the People." The Earl of Northbrook, who presided at the meeting, bore testimony to the importance of the subject, and to the exceptionally interesting manner in which Sir William Hunter had dealt with a difficult and delicate theme. On March 16th, Dr. F. J. Mouat read the fourth paper of the Session. His subject was "The Development and Influence of Universities in India," and as Dr. Mouat took a prominent part in founding the first university in India, he was able to give from his personal knowledge a striking and, to some extent, novel account of the origin of the whole matter. The fifth paper, read on April 13th, was by Mr. W. R. Robertson, Superintendent of the Agricultural Farm in Madras, and it was entitled, "The Experiences of Twenty Years in Conducting Agricultural Inquiries in Southern India." The title speaks for itself, and the author was able to impart much valuable information from the experiments conducted under his auspices, at Saidapet and elsewhere in the Madras Presidency, which the chairman, Sir James Caird, was able to supplement out of his own experience. The sixth and closing meeting of the Session was on May 4th, when Surgeon-General Bellew, C.S.I., read a paper on "The Effects of Canal Irrigation on the Health of the Punjab." Although Dr. Bellew's remarks were mainly supplementary to a paper read by Mr. Thornton, at an ordinary meeting of the Society, they furnished much fresh material relating to the great province of the Punjab, of which the author enjoyed a special knowledge. This paper had to be hastily arranged, in consequence of Dr. Leitner's ill-health preventing him from giving his promised paper on "Caste."

III.—Foreign and Colonial Section.

Six meetings of this Section have been held during the Session. On January 17th, Mr. A. J. R. Trendell read a paper upon "The Colonies of the Netherlands," in which he traced the rise and progress of Dutch colonial enterprise, and described in detail the more important of the possessions of Holland in the East. On February 10th, Mr. H. Coppinger Beeton, Agent-General for British Columbia, gave an exhaustive description of the resources of that colony, special prominence being given both by him and by the speakers who took part in the discussion to the advantages of British Columbia as a field for emigrants with capital. On the 24th of the same month, Mr. W. H. Penning read a paper upon "The Goldfields of the Transvaal," in the development of which so much enterprise is at present being displayed. On the 16th March, Mr. Stephen Jeans described the efforts which are being made, under the auspices of M. de Lesseps, to pierce a canal through the Isthmus of Panama, and touched upon the rival schemes for connecting the Atlantic and Pacific Oceans. Mr. W. F. Buchanan read, on April 17th, a paper upon "New South Wales," in which he traced the rise and progress of that colony during the past century of its existence. The last meeting of the Session took place on May 15th, when Mr. James Rankin, M.P., read a paper upon "The Duty of the State towards Emigration," and the necessity of the Legislature intervening for the relief of the congested condition of our population.

IV.—Section of Applied Art.

The subjects dealt with during the present Session, in the Section of Applied Art, range over a varied field, and at the several meetings, Bronze Monuments, Persian Textiles, Bookbinding, Architecture, and Colour in Decoration, were treated of, and the relations of craftsman and manufacturer were discussed. At the first meeting, on January 31st, an instructive paper was read by Mr. J. Starkie Gardner, on "Monumental Uses of Bronze," which may be considered as a com-

panion to his paper last Session on "Wrought Ironwork." The author, by means of the lantern, brought before his audience representations of nearly all the historical bronze monuments in England, as well as some of the chief specimens abroad. At the second meeting, a paper was read by Mr. H. B. Wheatley, entitled "Principles of Design as applied to Bookbinding." In connection with this meeting, an Exhibition of Examples of Historical and Modern Bookbindings was arranged in the Library, which remained open for ten days, and was visited by a considerable number of connoisseurs and practical bookbinders. On March 20th, Mr. William Simpson asked the question, "What Style of Architecture should we follow ?" in a paper which originated a lively discussion among the architects present at the meeting. On April 24th, Mr. Lewis F. Day urged the inutility of the middleman in art, in an interesting paper on "Craftsman and Manufacturer." Mr. J. D. Crace read a valuable paper on "The Decorative Use of Colour," on May 6th, in which he pointed out the need of considering colour as a means of laying stress on the main constructive features of a building. The work of the Section was brought to a close on May 29th, by a paper on "Persian Fabrics," by Mr. Cecil Smith, which was fully illustrated by a series of fine specimens of various textiles, brought from Persia by Mr. Smith.

V.—Cantor Lectures.

There have been six courses of Cantor Lectures during the past Session. Two of these dealt with subjects of applied art, Mr. Statham's course on "The Elements of Architectural Design," and that by Mr. G. Aitchison on "Decoration." It had originally been intended that Mr. Crane should give a course on the illustration of books, but circumstances prevented his being able to fulfil his engagement, and Mr. Aitchison kindly undertook, at rather short notice, to supply its place. The Council look forward to Mr. Crane's lectures for next year. The applications of science as connected with our food supply also formed the subject of two courses of lectures. Mr. Gordon Salamon gave a course upon Yeast, which was fully appreciated by a large audience, mainly of persons connected with the brewing interests; while Mr. Bannister contributed an exhaustive and interesting account of the recent advances which had been made in the production and supply of milk, butter, and cheese. Professor Roberts-Austen, in his lectures on Alloys, brought forward some scientific views of considerable novelty and importance, and Mr. J. Mayall concluded, in a short course on "The Modern Microscope," the valuable series of lectures on the microscope which he gave two years ago.

VI.—Juvenile Lectures.

The Juvenile Lectures for the past Session were given by Mr. W. H. Preece, the subject being "The Application of Electricity to Lighting and Working." There were, as usual, two lectures, of which one was devoted to the electric light, the other to the application of electricity for the transmission and application of power; they were as interesting, and as fully appreciated by the audiences who listened to them, as the former admirable lectures of a similar character which Mr. Preece has given before the Society.

VII.—Dr. Mann Lectures.

Early in the Session, the Council received an offer from Mrs. Mann, the widow of the late Dr. R. J. Mann, to provide funds for a short course of lectures on the "Protection of Buildings from Lightning," the lectures to be called the "Dr. Mann Lectures," in memory of her husband. The Council readily consented to co-operate in establishing a memorial of a member of the Society so well known and so much respected as Dr. Mann, and they felt that no better way could be adopted than that of giving lectures which should bear his name, and deal with a subject towards the investigation of which he had done so much useful work. They invited Professor Lodge to deliver two lectures on the subject, and their choice was amply justified by the valuable and novel contributions to this branch of science which Dr. Lodge brought before the Society.

VIII.—Special Lectures.

In addition to the regular courses of lectures, a special course was given this year, by Prof. Herkomer, A.R.A., on "Etching and Mezzotint Engraving." This consisted of three lectures, the first two of which were devoted to etching, and the third to mezzotint. They were of a practical nature, and were intended to give the audience some information of the nature of the manipulations required for the various processes. They were fully illustrated, by examples of finished and unfinished work, plates in various stages, tools, and appliances

generally. The lectures were attended by very full audiences, and were greatly appreciated.

IX.—Canals and Inland Navigation.

In December last year, a suggestion was made to the Council, by the Railway and Canal Traders' Association, that a Conference on the subject of canals should be held by the Society of Arts. The suggestion was referred to a committee, which, after examining into the question, reported to the Council their opinion that such a Conference might usefully be held. The present condition of the inland water communications of this country has lately aroused a good deal of attention, and the fact that many of them have passed, or are passing, into the hands of railway companies, has, in the opinion of many, tended to put an end to a wholesome and serviceable competition between the two modes of carriage. It is certain that the canals of the country have not been kept up to a condition of their highest efficiency, and the question is an interesting one, whether this is merely a question of an inferior method of communication giving way to a superior one; or whether it would be desirable, in the interests of the commerce of the country, that there should be, side by side with our great railway system, a corresponding system of canals, for the economical transport of heavy goods, and goods in the case of which rapid delivery is not a matter of very great importance. The Council adopted the report of the Committee, and took immediate steps to organise a Conference, for the middle of May. Invitations were addressed to the principal authorities on the subject, and in response to these invitations a number of papers were sent in. These were read and discussed at the Conference, which was held under the presidency of the Chairman of Council, on the 10th and 11th of last month. The meetings were well attended by representatives of canal companies from all parts of the country, and others, and the proceedings attracted a great deal of interest. During the course of the proceedings a resolution was passed in favour of the necessity of encouraging the improvement and extension of the canal system by State acquisition, or otherwise, and urging the Council of the Society to petition Parliament for the amendment of the Railway and Canal Traffic Bill, so that local authorities might be authorised to constitute public trusts, for the development of canals. The Council, while entirely convinced of the importance of improving the canal system of the kingdom, felt that they could not fully endorse the terms of the resolution, and they have therefore determined to submit the full report of the proceedings to the President of the Board of Trade, leaving him to take such action in the matter as he may think proper.

X.—Albert Medal, 1887.

In March last, by command of the Queen, the Council of the Society attended at Buckingham Palace, when H.R.H. the Prince of Wales, the President of the Society, presented to Her Majesty the Albert Medal which had been awarded her for the year 1887. The Address read by His Royal Highness, and the reply made by Her Majesty, will be found in the *Journal*.*

XI.—Albert Medal, 1888.

The Albert Medal for the present year has been awarded by the Council, with the approval of the President, to the distinguished German physicist, Professor Hermann Louis Helmholtz. Professor Helmholtz's scientific researches have extended probably over a wider range than those of any of his contemporaries, as they have included physiology, acoustics, optics, and electricity. The important character of his contributions to scientific knowledge are admitted by all those who are qualified to form an opinion, and the Council have felt that the bearing of his researches upon the practical arts and sciences was sufficiently important to justify the award of the Albert Medal, an award which it is not intended should be given for the promotion of pure science. Perhaps the most important of Professor Helmholtz's investigations, as regards their practical applications, have been those associated with sound and with light. These have had an important bearing on music and on painting.

XII.—Albert Medal Bye-laws.

In order to facilitate the award of the Albert Medal, the Council propose that clauses 72, 73, 74, and 78 of the Bye-laws shall be altered and hereafter read as follows:—

72. This Medal, instituted in 1862 as a memorial of H.R.H. the Prince Consort, for eighteen years the President of the Society, shall be awarded by the President and Council for "distinguished merit in promoting Arts, Manufactures, or Commerce."

73. The Medal shall not be awarded oftener than once a year, and may be awarded to persons of any nation.

* See *Journal*, March 9, 1888, p. 431.

74. No resolution of the Council relating to the award shall be passed unless 12 members at least be present, and 9 members at least approve thereof.

78. A Special Council shall be summoned with a notice of 14 days for considering the award.

XIII.—Medals.

The Council have awarded twelve medals for papers read during the past Session. Of these, six have been for papers read at the Ordinary Meetings, two for papers in the Foreign and Colonial Section, two in the Indian Section, and two in the Section of Applied Art. The Council also considered the paper read by Mr. H. B. Wheatley, on "Principles of Design, as applied to Bookbinding," as well deserving of a medal, which they would have awarded to him but for the fact that he is Secretary of the Section in which the paper was read.

The following is the full list of the awards:—

To Prof. Silvanus P. Thompson, for his paper on "The Mercurial Air-pump."

To Walter Emden, for his paper on "Theatres and Fireproof Construction."

To Sir Philip Magnus, for his paper on "Commercial Education."

To Swire Smith, for his paper on "The Technical Education Bill."

To Sir Howard Grubb, F.R.S., for his paper on "Telescopes for Stellar Photography."

To R. E. B. Crompton, for his paper on "Electric Lighting from Central Stations."

To Henry Coppinger Beeton, Agent-General for British Columbia, for his paper on "British Columbia."

To James Rankin, M.P., for his paper on "Emigration."

To Mr. Justice Cunningham, for his paper on "The Public Health in India."

To Sir William W. Hunter, K.C.S.I., C.I.E., LL.D., for his paper on "The Religions of India."

To J. Starkie Gardner, for his paper on "The Monumental Uses of Bronze."

To Cecil Smith, for his paper on "Persian Textiles."

XIV.—Prizes for Art-workmanship.

It was stated in the last Report of the Council that the Council had determined to renew the experiment of offering prizes for Art-workmanship, and the subjects in which prizes were offered were enumerated. For these prizes eighty competitors sent in specimens, entries being made in all the classes except the one for Enamelled Jewellers' Work. Ten prizes in all were awarded, of the total value of £195.* The collection of objects sent in may be considered to have been fairly representative, and in it a considerable amount of good work was displayed. The principal fault to be noticed was that the objects showed, in many instances, misapplied talent, and a misapprehension of the first principles of design; while there is no doubt that a large number of the articles would have been produced, and have found a market, without any special encouragement from the Society of Arts. The Council, however, believe that the encouragement to workmen resulting from the offer of prizes directly to them, and not to the manufacturer, was considerable, and that results of practical value may be hoped for from a continuation of the same action in future years. They have, therefore, determined to renew the offer for the present year, the subjects being Pottery, Stone-carving, and Wrought Ironwork. Under these three heads prizes amounting in all to £204 are offered.† The objects sent in in competition must be delivered by Tuesday, April 23rd, 1889. The general conditions of the offer are similar to those of last year.

XV.—Owen Jones Prizes.

These prizes have been awarded annually since 1879 on the results of the annual competition of the Science and Art Department to students of the Schools of Art, who produce the best designs for household furniture, &c., on the principles laid down by Owen Jones. Six prizes were offered for competition last year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.‡ A similar number of prizes has been offered for the present year (1887-8), and the result of the competition will be published in the *Journal* as soon as the results have been received from the Science and Art Department.

XVI.—Swiney Prize.

The next award of the Swiney prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the

* See *Journal* for December 23rd, 1887, vol. xxxv., p. 115.

† See *Journal* for May 11th, 1888, vol. xxxvi., p. 679.

‡ See *Journal* for August 19, 1887, vol. xxxv., p. 869.

same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by Maclise. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

XVII.—Motors for Electric Lighting.

It will be remembered that the date up to which entries could be received from competitors for the medals offered for prime movers suitable for electric lighting was postponed until the end of last year. Although the number of entries received at that date was not so large as the Council had anticipated when the offer was made, they were yet sufficiently numerous and sufficiently representative to justify the Council in proceeding with the tests. The Committee, therefore, appointed for the purpose continued their labours, and proceeded with the arrangements for the tests. It was intended that these should have taken place during the present month, but the difficulty of finding a suitable locality, and other circumstances caused some delay, and it was ultimately decided that the date should be fixed for September, this particular time having been selected to avoid clashing with the date of the Royal Agricultural Show. The difficulty of site has been got over by the Council of the Imperial Institute having kindly granted the use of a portion of the ground at South Kensington, on which the buildings for the Institute are being erected.

At the request of the Council, Dr. Hopkinson, Professor Kennedy, and Mr. Beauchamp Tower, have accepted the office of judges.

XVIII.—Examinations.

The Council are pleased to be able to report a distinct advance in the results of the Society's Examinations for the present year. The number of candidates shows a gratifying increase, there having been 1,433 this year, against 1,232 last year, or an increase of 201. The number of papers worked was 1,531, compared with 1,315 last year, or an increase of 216. The increase shows itself in most of the subjects. In Shorthand alone has there been a considerable decrease—285, as compared with 323. This decrease may certainly be attributed to the greater stringency of the preliminary examinations which have been adopted in certain of the Institutions sending up candidates for examination. The Examiner reports a decided improvement in the character of the papers, and notices that the number of rejections, 101, is still large, amounting to 35½ per cent. of the whole; this compares favourably with the 47 per cent. rejections of last year. The standard also for the minimum qualification has been raised. In Theory of Music, also, there is a falling-off, though but a trifling one—182, against 196. The average of failures in this subject is small, and the Examiner reports an improvement on last year. In Spanish, there were last year 29 candidates, but only 17 this. All of these, however, passed; nine of them in the First-class. For German there were 36 candidates, as against 48 last year, but the Examiner reports that the present year's examination in this subject was one of the most satisfactory he has ever conducted for the Society. With the diminished number of candidates, the number of First-class certificates was almost as high, there having been 17, as compared with 18 last year.

In all the other subjects there has been an increase. In Arithmetic there were 113, against 108. The Examiner does not note any advance in the qualifications of the candidates in this subject; the per-centage of failures was higher than last year, and the number of First-class certificates lower. The attention of candidates might usefully be directed to the valuable suggestions contained in the report of the Examiner. It was in Book-keeping that the principal increase has been manifested, the attention of candidates having been doubtless drawn to this important subject by the discussions which have taken place during the past year on the subject of Commercial Examinations. There were 591 candidates this year, against 348 in 1887, and the per-centage of First-class certificates was 16·41, the average per-centage of First-class for the past six years being 10·1. The proportion of candidates not passed has, as the Examiner remarks, undergone a diminution as gratifying in its way as the increase in the number and proportion of First-class certificates. In English there were 108 candidates; last year there were 100. The proportion of failures is smaller, there were only 34, whereas last year there were 44; but the per-centage of First-class certificates is also smaller—5 as compared with 7. French shows a satisfactory increase—116 against 98; but the per-centage of failures has increased in much more than a corresponding ratio. There was

one more candidate in Italian—8 as compared with 7; but the number of certificates in the three classes this year was identical with the number of last year, and there was one failure, whereas last year all the candidates passed.

Last year there were no candidates in Political Economy, and it is satisfactory to note that 14 entered for the present examination. To none of these, however, could the Examiner (Professor Foxwell, who has taken the office held by the late Professor Bonamy Price) award a First-class certificate. In Domestic Economy there were 61, as compared with 58. The per-centage of First-class certificates was about the same, but a much smaller proportion of candidates failed. The very important subject of Commercial Geography and History has again failed to attract any candidates, a result which the Council cannot but regard as most unsatisfactory.

It will be admitted that the figures above given suffice to justify the remark previously made, that the Society of Arts Examinations have shown distinct and gratifying progress during the present year.

With a view of encouraging still more the study of modern languages, the Council have determined to add to the subjects, in which examinations will be held next year, the following:—Portuguese, Russian, Chinese, Danish, and Greek (modern). They hope that the necessary number of candidates may be forthcoming in each of these subjects, but if the number should in some cases fall short of the twenty-five required under the regulations, the examination will be held notwithstanding. It may be mentioned that an application was received from an institution in Canada, asking if the Society's examinations could be extended to the Dominion. After careful consideration the Council decided that the application could be answered in the affirmative, and arrangements were made for including Canadian candidates in the present examination. It was, however, found that the time available was too short, but the Council hope that next year some candidates from the Dominion may be entered.

XIX. — Examinations in Commercial Knowledge.

With a view of supplying the want to which attention has been drawn in various quarters, of an examination in subjects of a special commercial character, the Council have prepared a scheme of examinations in Practical Commercial Knowledge. In the first instance they propose to examine candidates in two divisions only—the Commerce of Food and the Commerce of Clothing. Other divisions will be added as experience may show to be desirable. Candidates for these examinations will be required to have passed certain preliminary tests,* and they will then be expected to answer questions as to sources of supply of the various products, the countries producing them, their nature, methods of testing, substances used in adulteration, values, methods of importation, cost and methods of transport, foreign markets, discounts, trade allowances, shipping insurance, customs duties, &c.

The examinations will be held at the same time, and under the same regulations, as the Society's general examinations, and full particulars will be given in the programme which will shortly be issued for next year.

XX.—Practical Musical Examinations.

The usual examinations in practical music were this year held in London. There were 259 candidates, who took 260 certificates—94 first class, and 166 second class. Three of the candidates also took second-class honours. It should be stated that many of the candidates were examined in vocal as well as in instrumental music, and consequently the number of certificates awarded does not agree with the total number of candidates passing. There was a large increase in the number of candidates, as compared with those of previous years, the highest number in any previous year having been 198. The number examined last year was 188. The per-centage of failures is also smaller than last year, when 16 out of 188, or 9·5 per cent. failed. This year only 14 out of 259, or 5·9 per cent. failed. The instruments included the piano, organ, harp, harmonium, violin, and violoncello. As a question of educational value, it is encouraging to be able to state that the character of the Society's examination seemed to be better understood than upon former occasions. Not a few of those who had sent pupils for examination had made very careful and proper preparation. These obtained a due share of marks. The Examiner reports that many of the pieces were very carefully prepared, and that there was much more readiness in reading, and in recognising the sounds given for the ear-test, this year, than in times ast. It is, therefore, not unreasonable to assume that the increase in the number of

* For a syllabus of the Examinations see *Journal* for March 16, 1888, p. 462.

candidates tends to show that the value and importance of the examination are well estimated.

The examination for honours brought forward some interesting examples of steady work, which it is pleasant to notice. The certificates of the Society, as testimonies of actual and legitimate labour accomplished, are highly prized by the holders, and are generally recognised as proofs of proficiency. They have therefore, not only an honorary, but an actual commercial value, as indisputable evidence of good and honest work.

XXI.—Silver Wedding of H.R.H. the President.

An Address was presented to H.R.H. the Prince of Wales, the President of the Society, on the occasion of the Twenty-fifth anniversary of his Royal Highness's Marriage. At the commencement of the next Session of the Society, his Royal Highness enters upon the twenty-fifth year of his Presidency, he having taken that office for the first time in 1863.

XXII.—Barcelona Exhibition.

At the request of the Secretary of State for Foreign Affairs, the Council undertook in March last to render any assistance they could to the interests of the Barcelona Exhibition in this country, and to act as an intermediary between British exhibitors and the Executive of the Exhibition. At the time when these duties were undertaken the date for the receipt of applications from foreign exhibitors had already passed, and the Exhibition itself was announced to be opened on the 9th of April. It was not, therefore, possible that very much could be done to assist the formation of a British Section, but immediate steps were taken to advertise the Exhibition, and those exhibitors who applied to the Society were at once put in communication with the local authorities. The Exhibition was inaugurated by the Queen-Regent on the 20th of May.

XXIII.—National Co-operative Exhibition.

In February last, an application was made by the National Co-operative Association asking if the Society would assist in the holding of an exhibition of articles made by workmen-members of co-operative factories, which it was proposed to hold at the Crystal Palace during the summer, by appointing judges to make the awards in the different sections of the exhibition, and presenting medals, or other prizes. After giving careful attention to the question, the Council decided that the exhibition appeared to be one which might usefully be encouraged by the Society, and they therefore informed the Board of the Association that they would offer a Society of Arts Bronze Medal in each of the twenty classes into which it was proposed to divide the exhibition, and that they would at the same time appoint judges to award these medals, and any other prizes which might be given in connection with the exhibition.

XXIV.—Conversazione.

The Conversazione for the present year was held, by permission of the Lords of the Committee of Council on Education, at the South Kensington Museum. The authorities of the Department having stipulated that no tickets for the Conversazione should be sold, the Council was not able to carry out the arrangements which had been successfully made of recent years. The Department also objected to any of the cases in the Museum being shifted from their places, so that it was not possible to make the usual convenient arrangements for the reception of the hats, cloaks, &c., of the visitors. The Council therefore arranged for the erection of a special iron building as a cloak-room, an arrangement which, though the accommodation was too limited, appeared to be the best that could be devised under the circumstances.

XXV.—Obituary.

Although the losses which the Society sustained by deaths during the year just completed were less numerous than in the preceding year, they were yet very heavy. Two members actually serving on the Council died, Mr. Grierson—who had only recently been elected upon it, and, indeed, had only attended one meeting—and Mr. Crampton, who had served on it since 1882, and had been a subscribing member of the Society since 1846, in which year he received one of the principal honours in the power of the Society to bestow, the gold Isis medal. The locomotive for which this medal was awarded also obtained for its designer the Grand Medal of the Great Exhibition of 1851. Admiral Ryder had been a member of the Council, but he retired from office in consequence of his non-residence in London. He was for many years, both on and off the Council, a very active member of the Society, and he obtained the

Society's assistance in much of the useful work to which he devoted a large part of his life, that of saving life at sea. Mr. Robert Hunt was a member of the Society of Arts from 1852 to 1878, when advancing years led him to retire. He also served on the Council, having been elected thereon in 1861. Mr. George Godwin was another old member of the Society, he having become a subscriber in 1856.

Mr. J. T. Wood was a very active member of the Committee of the Indian Section, since its establishment, and Dr. Percy Badger served on the Committee of the African Section, when it was first formed, and afterwards on that of the Foreign and Colonial Section. Professor De Chaumont's membership of the Society of Arts dated from 1878. He was a constant attendant at meetings at which sanitary subjects were discussed, and took part in the proceedings of most of the Society's Sanitary Conferences. Professor Bonamy Price was the Society's Examiner in Political Economy. Sir Henry Maine and Professor Leoni Levi both of them received the Swiney Prize, Prof. Levi having been the second recipient, and Sir Henry Maine the fourth. Mr. J. C. Morton had read several valuable papers on agricultural subjects before the Society of Arts, for two of which he received the Society's Medal. Amongst other names which ought not to be passed over, are those of Sir Christopher Rawlinson, Sir Charles Bright, Sir Ashley Eden, General Hyde, and Mr. Thomas Routledge, who specially devoted himself to the introduction of new paper stuffs. Obituary notices of all these, and other members of the Society who died during the past year, will be found in the columns of the *Journal.*

XXVI.—New Council.

The following Vice-Presidents retired from office this year by seniority:—The Duke of Abercorn, Sir Douglas Galton, Mr. George Matthey, and Mr. W. H. Preece. The death of Mr. T. R. Crampton occasioned another vacancy, and Sir Owen Roberts resigned his place as a Vice-President in order that he may offer himself for election as Treasurer, in the place of Mr. W. R. Malcolm, whose term of office has expired. His Royal Highness the President, acting under the authority of the bye-law which empowers him to nominate for election not more than four Vice-Presidents, has nominated the Duke of Abercorn. To fill the vacancies the Council recommend for election:—The Lord Mayor; Sir Francis Dillon Bell, K.C.M.G., C.B.; Colonel Sir Owen Tudor Burne, K.C.S.I., C.I.E.; R. Brudenell Carter, F.R.C.S.; Thomas Hawksley, F.R.S.; Sir Robert Rawlinson, K.C.B. The Lord Mayor and Mr. Hawksley, though both of them old members of the Society — the Lord Mayor joined in 1876, and Mr. Hawksley in 1868 — have neither of them served on the Council before. Sir Robert Rawlinson has held office previously, having left the Council in 1886; while Sir F. Dillon Bell and Mr. Brudenell Carter are both of them at present ordinary members of Council. The four ordinary members of Council retiring are Mr. Charles Barry, Sir F. Dillon Bell, Mr. Brudenell Carter, and Sir Saul Samuel. To fill these places the Council recommend for election:—Mr. Benjamin Baker, Mr. Michael Carteighe, Mr. Myles Fenton, and Mr. J. Biddulph Martin. Mr. Malcolm, having held office as Treasurer since 1883, his place becomes vacant, and as above stated, the Council propose for it Sir Owen Roberts, who has acted previously in the same capacity.

XXVII.—List of Members.

The list of members shows a slight decrease, at which more regret than surprise will be felt, considering the condition of trade during the past year. The total number of life members, subscribing members, and institutions in union which subscribe to the Society from their own funds, is now 3,473. The numbers last year were 3,569. During the year 1887-8, 332 members have been removed from the list by death or resignation. During the same period 236 have been elected.

XXVIII.—Finance.

Full details of the financial affairs of the Society of Arts for the past year will be found in the Treasurer's Statement, which, according to the provisions of the Bye-laws, was published in the last number of the Society's *Journal.* There do not appear to be any items which require special explanation or comment. The finances of the Society are in a thoroughly sound state, as is proved by the fact that its funded property has now reached the amount of £11,500, £1,100 of which was invested during the financial year just completed. The Society also holds funds to which certain trusts are attached, amounting to £14,000. The liabilities of the Society at the present moment are very slight, as will be seen on an inspection of the Statement of Assets and Liabilities.

The CHAIRMAN, in moving the adoption of the Council's Report, said he must congratulate the Society upon its very satisfactory financial condition. He regretted the slight diminution which had taken place in the number of the members, but trusted the new branches of work which the Society was taking up would be the means of attracting many new supporters.

Mr. W. ANDERSON seconded the adoption of the Report.

Surgeon-Major INCE, M.D., commented upon the satisfactory nature of the Report, and said he was very glad to find that the Council intended to continue the offer of prizes for Art-Workmanship, besides endeavouring further to promote the important subject of commercial education. Referring to the financial statement, he thought the item of salaries bore too large a proportion to the total amount of the Society's income.

Mr. HYDE CLARKE, while concurring in many of the remarks made by the last speaker, said that he could not agree that the salaries of the staff were in any way disproportionate considering the work of the office. He was pleased to see that additional modern languages had been included in the scheme of the Society's Examinations, and suggested that the Japanese language might advantageously be added to the list.

Mr. W. LASCELLES-SCOTT referred to the decrease in the number of members, for which he thought the reason given as to the bad condition of trade was scarcely sufficient. He thought a larger amount of revenue might have been derived from the advertisements in the *Journal*.

Mr. THOMAS HILTON referred to the arrangements made for the Conversazione, and thought that the plan adopted many years ago of holding two or three Conversazioni in the course of the year, at a smaller cost for each, was preferable to the present custom of holding only one.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.
H.R.H. Prince Albert Victor of Wales, K.G.
Sir Frederick Abel, C.B., D.C.L., LL.D., F.R.S.
Duke of Abercorn, C.B.
The Attorney-General, M.P.
Sir Francis Dillon Bell, K.C.M.G., C.B.
Sir Edward Birkbeck, Bart., M.P.
Sir Frederick Bramwell, D.C.L., F.R.S.
Colonel Sir Owen Tudor Burne, K.C.S.I., C.I.E.
Alfred Carpmael.
R. Brudenell Carter, F.R.C.S.
Sir Daniel Cooper, Bart., G.C.M.G.
Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.
Prof. James Dewar, M.A., F.R.S.
Major-General J. F. D. Donnelly, R.E., C.B.
Thomas Hawksley, F.R.S.
Sir Frederick Leighton, Bart., P.R.A.
Sir Villiers Lister, K.C.M.G.
Duke of Manchester, K.P.
The Lord Mayor.
General The Right Hon. Sir Henry F. Ponsonby, G.C.B.
Sir Robert Rawlinson, K.C.B.
Lord Thurlow, F.R.S.

ORDINARY MEMBERS OF COUNCIL.

William Anderson.
Benjamin Baker.
William Henry Barlow, F.R.S.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Michael Carteighe.
Sir Juland Danvers, K.C.S.I.
Sir Henry Doulton.
Myles Fenton.
Colonel A. C. Hamilton, R.E.
John Biddulph Martin.
E. C. Robins, F.S.A.
Lord Sudeley, F.R.S.

TREASURERS.

B. Francis Cobb.
Sir Owen Roberts, M.A., F.S.A.

SECRETARY.

H. Trueman Wood, M.A.

The CHAIRMAN then moved the usual vote o thanks to the Scrutineers, which was carried unanimously.

Mr. HYDE CLARKE proposed a vote of thanks to the Chairman and the Council, and wished to include the permanent staff of the Society.

Mr. HILTON seconded the proposition, and the CHAIRMAN briefly returned thanks on behalf of the Council and the officers of the Society.

Miscellaneous.

WOOL PRODUCTION.

The *Journal de la Chambre de Commerce de Constantinople* says that up to the present time no information on the subject of the

total wool production of the world has been available. This information has now been supplied by M. Leroy, who has recently been entrusted with a special mission by the French Minister of War, and has studied the question from the point of view of the manufacture of army clothing. M. Leroy states that the total wool production of the world may be estimated annually at 800,000,000 kilogrammes—the kilogramme being equivalent to 2·204 lbs. avoirdupois—representing a total value of 3,000,000,000 francs, or £120,000,000. Australia and New Zealand own 75,000,000 sheep, producing 100,000,000 kilogrammes of wool, valued at £24,000,000 sterling. At the Cape of Good Hope, the sheep produce 15,000,000 kilogrammes of wool, representing a value of £2,000,000 sterling. At La Plata it is estimated that there are no less than 100,000,000 sheep, producing 50,000,000 kilogrammes of wool, worth about £10,000,000 sterling. In the United States the 50,000,000 sheep do not afford sufficient wool to meet the requirements of the country, and the consequence is it finds itself under the necessity of importing large quantities of wool from La Plata and Australia. Europe possesses 200,000,000 sheep, giving 200,000,000 kilogrammes of wool, valued at £36,000,000 sterling. Morocco, Algiers, and Tunis produce considerable quantities of wool; while in France, forty years ago, there were 35,000,000 sheep, but in consequence of the increase in the price of meat this number is now reduced to 22,000,000. In Europe, Russia holds the first rank as a wool-producing country, England, Germany, France, Austria, Italy, and Spain ranking next in importance. The old Spanish flocks of Merino sheep are now replaced by those of Rambouillet and Vineville, which export their magnificent wethers to all parts of the world. India, Central Asia, and China are estimated to produce 150,000,000 kilogrammes. Of the total of 800,000,000 kilogrammes, representing the world's wool production, the greater part of the wool from Australia, New Zealand, Cape, and La Plata, is imported at London, Antwerp, Liverpool, Bremen, Havre, Marseilles, Dunkirk, Bordeaux, and Genoa. The wool industry is said to consume annually 100,000,000 kilogrammes of the raw material.

General Notes.

Bethnal-green Museum.—A private view of the objects of Art lent for exhibition in this Museum by the Hon. W. F. B. and Mrs. Massey Mainwaring took place on Wednesday, the 27th inst. The collection, which is especially rich in examples of Dresden china, old silver plate, and furniture, is now open to the public.

Tunnel at Schemnitz.—One of the longest tunnels in the world is the one at Schemnitz, Hungary. It has a length of 10·27 miles—1 mile longer than the St. Gothard, and 2½ miles more than the Mont Cenis Tunnel. When the contract was made, in 1872, the work was let at about 35 dols. a yard, but for some years before its completion the cost was about 110 dols. a yard.

Cheese Exhibition at Aosta.—The *Board of Trade Journal* refers to a communication which has been received from the Foreign-office, enclosing copies of the regulations of the forthcoming native exhibition of cheese at Aosta, to which is to be annexed an international exhibition of utensils and ingredients for the manufacture of cheese. This exhibition will be opened on the 15th September, and will close on the 24th September next. In the exhibition of utensils and ingredients for the manufacture of cheese, products made in Italy or abroad will be admitted, provided that the latter are presented by native houses. Demands for admission to the exhibition should be addressed to the President of the Executive Committee at Aosta before the 16th July proximo. The regulations may be seen on application at the Commercial Department, Board of Trade, S.W.

Patent-office.—The fifth report of the Comptroller-General of Patents, Designs, and Trademarks for the year 1887 has just been published as a Parliamentary Paper. The total number of applications for patents in 1887 was 18,051, for designs 26,043, and for trade-marks 10,586. These numbers are considerably in advance of the average of the three previous years. It appears from a table given that the proportion of applications made by persons resident in the United Kingdom was 76 per cent.—a total which varies but slightly from the average. Of the applications made during the year 53 per cent. were proceeded with. There were 26 applications made under the provisions of the International Convention, which was joined during the year by the Government of the United States. With regard to trade-marks, 4,916 marks were advertised and 4,740 were registered. The total receipts for the year amounted to £124,279, of which £105,599 was for patent fees, £4,855 for designs, and £8,463 for trade-marks, while £5,360 was received from the sale of publications. The chief items of expenditure were £47,110 for salaries, £2,304 for pensions, £3,050 for stationery, and £22,300 for printing specifications, lithographing, drawings, and other such expenses. A balance of £42,702 was left at the end of the year.

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FRIDAY, JULY 6, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

Prizes are offered to Art-workmen in the following classes:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5; second prize, £2.
   b. Shaved or turned, first prize, £5; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.
   c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for the outside of a window, for a street-door panel, or for indoor use as a window screen, coil case, ventilator, &c.

All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered have appeared in previous numbers of the *Journal.** They can also be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

DECORATION.

By Professor G. Aitchison, A.R.A.

Lecture I.—Delivered April 30th, 1888.

It is a triple pleasure to lecture to you, first, because I once sat and listened on those benches which I now address; secondly, from the memories which crowd the mind of great thoughts, great aims, and great men, inseparably connected with this Institution; and thirdly, because the Society of Arts was, I believe, the first public body in England that lent its walls to be adorned with painting, when the Chapter of St. Paul's refused the walls and domes of its cathedral.

The Society of Arts has been the mother of that large family of societies whose objects are the health, comfort, and cultivation of the people, the improvement of its manufacturing appliances, and the spread of its trade and commerce.

Some of those ideas and some of those efforts that were once here localised have since been transformed into vast departments of the State; here, too, the fine arts were encouraged before the foundation of the Royal Academy of Arts; whilst to give a list of the

* See *Journal*, June 15.

great men who have adorned this Society, or have charmed its audiences, would exceed in length Homer's "Catalogue of Ships." At this moment I am thinking of that illustrious architect, my friend the late W. Burges, who lectured on a cognate subject some 25 years ago.

In 1783, that eccentric genius, James Barry, completed those pictures you see around you, to which he had devoted the prime years of his life. Canova, when here, so admired "The Victors at Olympia," that he said "he would have come purposely to England from Rome to see it, without any other motive, had he known of the existence of such a picture." The Society may even now point to this as a great achievement, for in this respect England is more backward than it was a century ago, though its riches have enormously increased. Setting aside the pictures in the Houses of Parliament, which are wholly due to the influence of the late Prince Consort, no such pictures have been painted but "The Arts of Peace and War" at South Kensington, by Sir Frederick Leighton, the picture in St. Paul's by Mr. Watts, and the mosaic of "St. George" by Mr. Poynter in the Houses of Parliament.

Every public building in England cries aloud for completion by painting and by sculpture; in some cases the funds are actually in hand. There is a galaxy of English artists, equal—or nearly equal—to the greatest who have ever lived, who are burning to adorn our national monuments, and to remove the reproach from our country that we care not for the fine arts; but the spirit of the country has so flagged, that any day we may expect to hear that although the funds have been collected for adorning some public monument with painting or sculpture, they have been dissipated in a less worthy way. The very modest suggestion of Lord De Lisle that the Central-hall of the Houses of Parliament might be finished, *i.e.*, have the blank spaces filled in with mosaic pictures, to match the "St. George," did not even meet with a response from one of the crowd that struggle there for power or place.

I think before entering on the subject of *Decoration*, I should combat a sort of survival of Puritanism amongst a generation that are by no means puritanical, except, perhaps, in that particular mentioned by Macaulay on the suppression of bear-baiting. "They put it down," he says, "not because it hurt the bear, but because it pleased the people." There is still a feeling that it is more respectable to expend money on oysters and white wine, if given to our acquaintances, than to squander it on the fine arts. The only visual fine art that flourishes in England is painting; considering the absence of lovely colour in our buildings and in men's clothes, the want of sunshine, and the general grime of our capital and the manufacturing towns, it is not surprising that there should be a desire for colour; but I fear that painting is still more encouraged for another reason, *i.e.*, that if the pictures are well chosen, they bring a better return than the funds. Sculpture, for want of patronage, is languishing almost to death, and architecture only exists as a fine art because architects present the fine art portion to their clients.

Before we go into the technical part let us try and learn from nature what she thinks of the admiration of the beautiful. Man has to work hard for his livelihood, particularly in this inclement, naturally sterile, and over-populated part of the world, though I am not inclined to think hard work a curse if the work be wholesome, and the workers can obtain by it proper food, clothes, and lodging, and have proper leisure. Aristotle (Politics, Lib. 5, cap. 3) says:—"The endeavour of Nature herself, as we have frequently remarked, is that men may be able not only to engage in business rightly but able to spend their leisure nobly;" and he goes on to say that, "leisure is preferable to business, and is the end of human existence."

What does Nature say to the employment of this leisure? Has she not spread a sky over our heads of ever-varying aspect, both in form and colour, from the blue vault smiling in the sunshine to the black army of clouds pregnant with the tempest and the thunderbolt? Have we not, as a rule, a constant procession of lovely effects, from the saffron tint of the morn, with its shoals of pink and purple cloud, to the crimson blaze of sunset; and as the reflections of the glorious orb die away, is not the darkened vault studded with stars, of every variety of colour and brightness? Nothing has so often moved the souls of poets, from Job to the Poet Laureate, to admiration, praise, or adoration as the stars. Job makes the Almighty ask him:—"Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion?" and the latter says:—

> "Many a night I saw the Pleiades, rising thro' the mellow shade,
> Glitter like a swarm of fire-flies tangled in a silver braid."

Nothing, too, has been a more frequent or

more lasting subject of decoration than the Constellations and the Zodiac, clothed in human form by Egyptian or Greek.

The moon, particularly when it is struggling through the clouds, has also been one of the favourite subjects for the painter and the poet :—

> "And oft, as if her head she bowed,
> Stooping thro' a fleecy cloud."

Are the woods and mountains, the seas, the rivers, and the lakes, one whit less beautiful? Is there no beauty in the grass and flowers of the meadows, in the shape, colour, and movement of animals, in the lightning-flash of the kingfisher or the dragon-fly? Is there no delight in the rustling of trees, the song of birds, the murmur of brooks, the rush of waterfalls, or in the roar or ripple of the ocean? Truly there are hideous forms and colours and appalling sights in nature, but are not the the bulk of her works and manifestations replete with beauty and with joyousness? Do you think these beauties were not given us for some end? To me it seems that this is the great lesson Nature tries to teach us—that to ennoble the soul, and to invigorate and refresh the mind after toil, we should admire the beauties of form and colour, of shade and sunshine, of silence and music, she has spread out for us without cost, and which only ask to be looked at with discerning eyes, and to be enjoyed with thankful hearts.

Decoration, in its earliest form, is the desire of man to adorn his body, his weapons, his implements, and afterwards his clothes and habitation, with some of those beauties he has observed in nature. The young negroes of Africa employ their leisure in modelling the cattle and other animals they see before them; the very savages who inhabited the prehistoric caves employed their spare time in engraving the beasts around them and their most striking actions on the bones they had picked; but few of the young Christians of England employ their leisure in so harmless and ennobling a way; so that the Abbé Listz's remark, that occasional stealing is much less brutalising than the continuous and persistent pursuit of gain, appears to be not far from the truth.

We have, in London, three things that are adverse to the embellishment of our lives. First, we live, as a rule, in hired houses; few, even of the wealthy, can obtain a freehold. No one will embellish his house with that which is beautiful, permanent, and costly, if some one that he neither knows nor cares for will, after a few years, enjoy it, and too, without paying one farthing as compensation for the outlay. This refusal to adorn a house for the landlord's benefit is particularly strong in the case of the leaseholder having children. Though the Irish landlord may not be quite perfect, he is not so exacting, rapacious, and unjust as the London one. This, too, which causes the severance of the sister fine arts from architecture, which is necessarily permanent and immovable, has a most disastrous effect on all three, for they were meant to go hand-in-hand like the Graces. Architecture loses its proper adornment and the human element to give it interest; painting and sculpture lose their foil in the rigid lines of architecture, their appropriateness for the particular place, and their monumental character; for if they do not form an integral part of the structure, they must be portable, and fitted for any other place.

Secondly, our clothes are not only ugly, but ignoble in form; sculpture or statuary, when used to pourtray man in the costume worn in England, I might say in civilised Europe, is impossible; the ablest sculptor can but turn out a scarecrow if he is bound to reproduce the actual clothes. To make a fine monument, the sculptor must clothe and surmount it with Greek ideal figures, and put a medallion or a bust only of the hero, unless he wants his work to become a laughing stock or an eye-sore. The colour, too, of men's clothes is always dismal, and mostly hideous as well.

Thirdly, in our buildings the atmosphere and its accompaniments almost forbid external colour in monumental materials, those materials that are unaffected by wet, frost, and the vitriol of the atmosphere, are soon covered with a pall of soot and dust. I refer you to the Westminster drinking fountain, by Teulon, once blazing with colour, for a confirmation of my remarks; and London is a Paradise as compared with some of our manufacturing towns.

What, however, is even more fatal than the three impediments mentioned, is the grovelling soul. It is often asked why there are less beautiful things produced in England now-a-days than there were amongst the Egyptians, Assyrians, Persians, Romans, and Mediævals, even than amongst the Norman and Saracen savages—who between them pretty nearly overran the world—not to speak of the Greeks and the Tuscans. It is because these peoples

had nobler souls and higher aspirations than we have now.

If a race cannot raise its desires above the stye and the trough, you can get nothing higher out of it by mere skill. I do not mean to libel my countrymen and the so-called civilised world by applying this diatribe to every part of them, but mainly to that which relates to visual beauty. There is plenty of benevolence, plenty of intelligence, plenty of scientific culture, some literature, eloquence, poetry, and music; but the very ignobleness of our dress shows that we are callous to visual beauty, and I am afraid, too, that we have a plentiful lack of lofty aspirations. Our aspirations fall far below the ideal of the Pagan philosophers, not to speak of the Christian saints. We seem to have taken for our text the title of a book by a late divine, "How to Make the Best of Both Worlds," and to think the best of this world is good eating and drinking.

I have dwelt long on this subject, because there is a disposition to believe that we can raise ourselves or our fellows to the heights once arrived at by merely mechanical means; but this is impossible if we lack the faculty, the high aim, and the enthusiasm. Colour blindness and musical insensibility are well-known physical defects which no teaching will cure at once, though it is probable that these defects may be partially cured in the individual, and eventually got rid of in the race. This insensibility to beauty exists for the same reason that the wing of the apteryx is no bigger than your thumbnail, it has shrivelled up through want of use. This age is beauty blind, and we should all set ourselves to cure this defect. To do so we must steadfastly try to love beauty, for we mostly end by loving what we try to when it is loveable. All the exquisiteness of form and colour we see in Nature was surely not wholly designed to please insects and the lower animals, and not intended for man's purification and delight. We do not even think so ourselves, for if we did we should not so extol the Greeks, the Tuscans, and the Venetians for their exquisite sensibility to the beauty of form or colour, and their love of reproducing one or both. As regards insects, we know that no young lady is so charmed by a new colour, or a new tone in a dress, as the bees are with them in a flower. Naturalists tell us that bees desert the flowers of the old colours and tones for the new ones, and that the faintest variation in their tones or tints will attract the bees in such numbers that the old plants often perish by their neglect. The peacock wooes his love by exhibiting his magnificent metallic shot plumage to her in every variety of light.

All arts flourish and arrive at perfection in proportion to the cultivation of the amateur. The creative soul is scarcer than the nobler precious stones; few of us, therefore, can expect to have it, but if we cannot create we can appreciate. Man for his highest external reward must impart wisdom or give pleasure, and reap fame, but how can men do either if their contemporaries care not for their works. You know the passage:—"Wisdom crieth without. She uttereth her voice in the streets," (Proverbs i. 20).

The ingratitude of mankind to its benefactors is scandalous, but it is bearable by them if they are appreciated and admired. Socrates was almost a pauper, and Diogenes begged his bread, but they were almost worshipped by hosts of their contemporaries, and their fame has filled the world ever since. Proper teaching in the Arts will make those who are fitted to learn, skilful, but it will not raise their souls. There were sculptors more skilful in the technical part of their art than Phidias, but according to all accounts the divine majesty of his Jupiter at Olympia was never equalled, much less surpassed.

It was his divinely inspired soul that sought in its enthusiasm to pourtray the majesty of the father of the gods. Technical skill has a merit and a charm of its own which all the cultivated must admire; but even when it can be carried to high perfection, it is only the outspring of a low kind of genius.

Works in which the loftiest aim and the most burning enthusiasm irradiate perfect workmanship, entrance and absorb us, and we call them the masterpieces of the world. Some of the seraphic sweetness of Raphael and the majesty of Michael Angelo are examples of this in painting and sculpture. We are not to suppose these lofty aims and this enthusiasm did not exist in them because they were occasionally betrayed into unworthy actions, for man is by no means a perfect creature.

We may see the works of art in a whole century stamped with a low aim, which is nauseous to an age with higher aims; whilst here and there we see rude works almost destitute of technical skill, but which have the stamp of a lofty aim, or a worthy love, that appeals to a more cultivated age.

I should like to see everyone cultivating a taste for beauty for its own sake; and none

of the subtler beauties that pervade the human form or flowers can be appreciated without imitating them by modelling; or by drawing, shading, and colouring. Everyone should deeply study nature and art, to ascertain what particular phase of form and colour most delight him, for if decoration is to be carried to any great perfection, it can only be through a general consensus of taste.

If you are ignorant of a subject how can you admire it? Supposing some learned mathematician were addressing us to-night on new flights of the differential calculus, those who understood the subject would be entranced, but those who knew nothing of it might as well hear a discourse in Greek, Hebrew, or Welsh; and what we neither understand nor admire we are naturally loth to reward.

Much of the apparent sordidness of this generation is owing to their deriving no pleasure from the beautiful works that are done for them, and having no judgment as to the class they belong to. An ordinary fiddler probably gets the wages of an ordinary mechanic; but a large body of the population are amateur fiddlers themselves, and a still larger number are judges of musical execution. Hence a master who can make his fiddle "discourse most eloquent music" has each note paid for in gold, besides being adored by those who are true critics.

The Greeks made drawing and modelling one of the four primary subjects to be learnt:—

1. Reading and writing.
2. Gymnastic, or those exercises that were done naked.
3. Music.
4. The arts of design.

They adored beauty, and by the institution of exercises in the nude, they not only learned to be critics of the human form, but this practice led each youth to be temperate, and to train his body to the utmost perfection; so charmed were the Greeks with the display of beauty, and so convinced were they of the national importance of such physical and moral perfection, that though the reward of victory, in the Olympian, Nemæan, and Isthmian games was but a crown of leaves, each victor was allowed to dedicate a picture or statue of himself, or to have a poem written in his honour. We cannot suppose that every athlete was a man of fortune, who could afford a statue by Phidias, Polycletus, or Praxiteles, a picture by Polygnotus, Parrhasius, or Zeuxis, a poem by Pindar; but his town, his village, or his ward were only too glad to be made famous by their champion, and cheerfully subscribed the requisite sum; hence the pitch to which sculpture, statuary, and painting arrived. Music with them meant not only harmonic sounds without words, but all the poetry that was sung to it, and the older poems were to them what the Bible is to us; and all that was rhythmical in sight, sound, or movement was included in the word music. The arts of design let every scholar into some of the secrets of beauty, both in form and colour, and acted as a sieve to separate those naturally gifted from the rest. Curiously enough, Aristotle overlooks this, and says, "Reading and writing, and the art of design, are taught for their serviceableness in purposes of life, and their precious utility." Besides this, beauty in itself was almost adored by them; Alcibiades refused to learn the flute, because it distorted the mouth, and the cogency of this objection was admitted.

The better sort of Roman, though the Romans were of a most inartistic fibre, copied in this respect the education of Greece. Plutarch says that Paulus Æmilius had his sons taught the "genteeler arts of Greece." "To this purpose he not only entertained masters who could teach them grammar, logic, and rhetoric, but sculpture also and painting;"* and remember that Scipio Africanus the younger was one of his sons. This training, therefore, neither produced cowardice nor effeminacy.

The importance that the Saracens gave to the mere contemplation of beautiful things was such that one of their writers says, when the narcissus is in flower, a man that can only earn enough to get three loaves of bread, which are barely enough for his subsistence for the day, should deprive himself of one loaf to buy a narcissus to admire.

This forms a good scale for us, by which we can judge if our love of the beautiful is strong enough to make us fast to enjoy it.

The highest form of decoration is painted figure sculpture, figure painting, and statuary. Considering the wealth of this nation, and the small remuneration excellent sculptors and painters are ready to work for, there must be a hundred thousand people in London who could afford a sculptured frieze on their house fronts, or a painted one in their drawing-rooms, even if they had to say, "I can enjoy it only all my life," although in some cases the indulgence might involve the sacrifice of

* Plutarch's "Paulus Æmilius," vol. 2, p. 264 (Langhorne).

oysters, turtle soup, and champagne for a year or two. Though, at present, I fear, that if most of our houses were freeholds, and the sculpture and painting were done for nothing (provided, of course, that they could not be sold), the owners would neither know what to have done, nor when done, would it, in their opinion, be worth the loss of occupation for the time it was doing.

Just consider the mental attitude of our people as compared with the ancient Greeks or the Italians of the Renaissance. These people looked on fine works of art as their most precious possession. Herodotus tells us that when Polycrates, the Tyrant of Samos, on account of his unvaried good fortune, was advised to sacrifice his most treasured possession, he threw into the sea his engraved signet; this was swallowed by a big fish, the fish was caught and presented to him, in it was found the signet, and Polycrates was eventually impaled.

The little tyrants of Italy, who Machiavelli said exceeded Nero in cruelty, generally considered some engraved gem, some medal, some little picture, or some statuette as their choicest possession. This shows what the general taste was, when even such monsters as these were imbued with a belief in its preciousness.

If we could once get Englishmen to love something beautiful, the fine arts might then enter on to a new career. Our machinery and mechanical appliances could furnish almost the poorest houses with copies of first-rate works of art if the demand once arose. It is, however, much more important that the outsides of buildings should be enriched with colour and lovely form than their insides. I may say that they are wanting in their first duty to the public if they are not beautiful, for they have not only taken some sky and air from us, and possibly flowers, trees, or herbage, but they help to poison the air by their smoke, dust, and exhalations. Even setting this aside, thousands instead of dozens see them, and when they have beauty they are the best schools, showing not only what might be but what can be done.

Beautiful colour alone is so precious to man that he pays enormous sums for those pebbles of different colours called precious stones, that when cut will shine and sparkle, though in most respects they are the most worthless of things. It is true that rubies do make bearings for the wheels of watches, and diamonds cut glass, engrave gems, and occasionally bore rocks. I have always thought that this natural hunger for colour appeared to mankind, even in early times, an insufficient excuse for paying large sums for this indulgence, they therefore invented other reasons. What they merely bought for pleasure was defended by fabulous reasons. The bloodstone got credited with protecting from lightning; green jade from certain diseases; some stones rendered their wearers invisible, like the ring of Gyges; and other stones had various qualities as amulets or talismans, about whose qualities we hear so much in the "Arabian Nights."

No natural materials with any beauty of colour, and that can be easily cleaned, resist our climate, and the atmosphere of manufacturing towns, but polished granite, porphyry, onyx, jasper, &c., and some of the metals, and of those materials made by man nothing but glass and enamelled bricks. Bronze, too, is not much more beautiful in colour than lead after a short exposure to the atmosphere of a manufacturing town; and the same may be said of silver, copper, and zinc. All marbles lose their polish, and are as well rapidly destroyed; possibly enamelling on copper or bronze might stand the climate, but I do not know that it has ever been tried. Enamelled iron certainly will not. Enamelled tiles crack, burst, and tumble off; so that for brilliant colour we have nothing to fall back on but enamelled bricks, coloured glass slabs, and glass mosaic.

Almost all the granites are poor in colour, porphyries are dark in tone, a few, however, of the Scandinavian ones are light, one, I recollect, is flesh colour, but the porphyries we mostly know are either purple, green, or black, and, like onyx, jasper, and chalcedony, are expensive to buy, and enormously costly to work; therefore, for any buildings but those for religious or public use, or for the very wealthy, we must fall back on enamelled bricks.

When I say except for religious or public use, I speak of what should be, and not what is. Our religious buildings are mostly the cheapest kind of brick or rubble shed that is wind and water-tight, fitted inside with the cheapest stone and wood, and the artistic accessories supplied by mechanics or advertising shops; where we might look for porphyry, marble, and jasper, we have Bath or Caen stone. No sane person would ever go into a modern church and expect to see the carving, whether floral or figure, done by our

first sculptors; nor painting by any artist of eminence; and yet people wonder why our churches are inferior to those of Roman, Mediæval, or Renaissance days, not to speak of the heathen temples, where the very best work and the very best materials were lavished. A stranger might think that if the people were not religious, they were patriotic, and endeavoured to get permanence, beauty, splendour, or magnificence in their public buildings; but though these may be favourably compared with churches, as far as materials go, perhaps Portland stone and oak instead of rubble and deal, yet for costly materials you would have to go to a draper's shop, a public house, or a pawnbroker's; and a good deal of the sculpture of our public buildings looks as if it were done by those sculptors who carve the figureheads of ships. The whole patriotism of the Government, as regards public buildings, is exhibited in seeing how little they can pay the architect and the contractor.

In the heathen temples at Athens the material was the finest marble; the work was day-work, so that the Athenians might get the best workmanship; and the best architects, sculptors, and painters that could be got were employed and handsomely paid.

The sculpture formed of enamelled bricks, brought by M. and Madame Deulafoy from Darius's palace at Susa, and now in the Louvre, shows what may be done with such a material; and what was done by the Persian potters on tiles may be done by our potters on bricks, for we are only confined by Act of Parliament to making our bricks $8\frac{1}{2} \times 4\frac{1}{4} \times 2\frac{3}{4}$, perhaps the most ridiculous size that could have been chosen. Examples of glass slabs are wanting, though you may recollect that one storey of Scaurus' theatre was made of them, but examples of glass mosaic used externally in London, that seem to withstand the climate, are plentiful, so that it is unnecessary to discuss glass mosaic now.

I want, in this lecture, rather to confine myself to the artistic side, than to expatiate on the materials and manufactured articles we have ready for the adornment of our buildings, when we can raise our souls to desire something beautiful; and although there are plenty of painters and sculptors to expatiate on the merits and advantages of their own arts, yet perhaps it comes with a better grace from one who is neither.

All decoration belongs properly to the painter or the sculptor, though it is more often than not done by the architect, but it is no part of his art, though by an extension of meaning a building is sometimes said to be decorated with mouldings. Architecture has its own work and its own laws, as well as others that belong to the arts generally, such as invention. Perhaps the greatest distinguishing mark of architecture as a fine art is to express with æsthetic propriety the destination of the structure, by arousing thoughts proper to that destination; it has to make the whole rhythmical and harmonically proportioned, to give variety and contrast by different shapes, and by different degrees, sizes, and shapes of shade and shadow, to give an appropriate outline, and, where the structure is made up of different parts in different places, to make the whole compose properly. The sculptor gives us the beautiful forms he sees in nature, and mostly those in organic nature, or the beautiful forms he has collected or deduced from nature, sometimes even those that have but a momentary existence, though, like the written word, sculpture is permanent, and except to show his skill or mastery in his art, the subject should be in repose. Sometimes, however, he has to reproduce evanescent expressions and actions, as smiling, frowning, laughing, crying, &c., and running, wrestling, boxing, quoit playing, javelin throwing, riding, driving, or swimming, a moving procession, or a battle; and in portraits he has to give us the individual lineaments, features, and the habitual expression with truth, though he does well to emphasize the nobler traits. I think I may say what we ask of him is to give us beauty of form in a permanent material, or to raise noble emotions in our souls, and to truthfully pourtray the form and lineaments of those we love, admire, or venerate. Though we mostly only ask for the natural shape, we do not deny him the use of drapery when that is noble or beautiful in form. But we do not ask the true sculptor to give us that which is not beautiful or ennobling merely because it may some day be archæologically interesting, like the Highlander at the snuff shop.

Painting, as far as form goes, is merely sculpture from one point of view, and what is said of the former may be equally said of the latter. What we ask of the painter is beauty of colour, or colour that arouses noble emotions; or in the case of portraiture, that which represents the actual facts; and when sculpture is not painted, as is mostly the case in statuary, painting can give atmospheric effects denied to statuary and unpainted sculpture.

If our own history is so bare of subjects that are worthy to be painted or sculptured, or the people are so ugly and badly dressed that it is merely ridiculous to portray them, we have the whole of the Scriptures at hand for the adornment of our churches, chapels, and cathedrals, and these have plenty of empty niches for statues, vacant pedestals for groups, pediments for reliefs, and covered porticoes for pictures in mosaic, without speaking of their interiors. Means in the shape of money are plentiful, nor is there a lack of artists, nor a difficulty in obtaining the requisite materials.

The same sort of compliment might be paid to this generation that one of the Greek kings paid to a soldier. He said, "he was like a sword-fish; he had a sword, but no heart."

We are a nation of sailors, and for some of our public buildings a depiction of sea fights or even of fleets of merchantmen would not be amiss; and if the grim ironclad, like a black porpoise, is felt to be wanting in picturesqueness, the curved prow, high stern, and swelling sails of early ships have always been a favourite subject with artists. Besides, if we have not stirring episodes enough in our own history for enriching public buildings, we can fall back on our own poets.

It may at first be thought that there are the fewest resources for houses, yet most persons, even if their whole life has been occupied in respectable plodding for gain, have at least had some episodes in the history of their family that are fit for sculpture or painting. There are incidents, too, in each man's calling which can be portrayed, not to speak of the whole of the poetry of the world.

Lord Beaconsfield said, "Adventures are to the adventurous," and the pith of this remark may be applied to picturesque or sculpturesque subjects, as well as to poetic ones. M. Van Haanen, at Venice, saw that stringing beads was a picturesque subject, and being a fine painter, made a splendid picture of it. I was once in a lace mill at Nottingham; the room, with the girls cutting up the lace, would have made an equally good picture had I happened to be a fine painter. In the most prosaic age there is stuff enough for poetry; in the most tasteless age there is beauty enough for fine pictures and sculpture, if there were poets, painters, or sculptors to appreciate and properly execute the beautiful things they hear or see; though we can hardly expect executants where there are no admirers. You all recollect Hogarth's etching of the hogs routing in the dunghill, while a celestial choir is singing above.

But even if these are not enough, there is the whole of Nature before you. Wild beast patterns are favourite subjects in the East for pottery, carpets, stuffs, and hangings. You must have a cat, a dog, or a canary bird. You have horses and sparrows before you, and not unfrequently, even in London, you may be visited by a pigeon, or a robin, if you put crumbs on your window sill; and if you do not care for these, you can have medallions of your own head and of those of your family joined in a band of formal ornament; this would be a great improvement to a wall with holes in it of common brick.

What may be called formal ornament is the application of certain observed facts in Nature that please. Up to a certain point the repetition of some simple form is pleasing, lines are said to be divided harmonically when they have certain ratios to one another, and spaces may have similar proportions, and these as well as certain curves give more pleasure than others; the combination of some flat and sharp curves is also found to be beautiful; the contrast of certain forms and of certain colours also gives pleasure. It is the evolution by man of these observations properly applied to things he wants that makes them ornamental, and their superposition on elegant forms is said to decorate them.

Mr. W. Morris once said, "People now-a-days do not want what is beautiful, but what is new." This, however, is not wholly true, for people really want what is beautiful, as well as what is new; they know what is new, but they do not know what is beautiful and make the mistake of accepting the new which they do know, instead of taking the old which is beautiful, when they cannot get both.

The number of creators in every art or science is small. I might say that great creators are scarcer than diamonds. We all feel that we are greatly in want of inventors and discoverers in every art and science. I will put a case that comes home to everyone in medicine. A great deal has been done in the present day in preventing illness; if we could get an instrument that bore the same ratio to the microscope as this does to the human eye, it is quite possible a great stride would be made in medicine, and every sick person would be a gainer.

The thing is to find your genius, and to

make it worth his while to invent what you want; you must first know what you do want, and then you must honour and reward the inventor. A healthy, vigorous, and virtuous population, with high aims, is the most likely stratum from which a genius may come; he then wants the opportunity of cultivating his powers in the right direction, and when he has invented, rewards in the shape of general esteem and honours, and, as often as not, in wealth. Though Socrates and Diogenes scorned wealth, Plato and Aristotle did not; and we all know Plato's answer to Diogenes, who said, when stamping on his purple carpets, "Thus do I trample on the pride of Plato." If you make it easy for every rascal to steal his invention, and deprive him of his labour, you do all that in you lies to discourage invention, and this is as true of ornament as of everything else. I believe in the great days of ornamental invention the ornamentalist was highly rewarded, both in wealth and honour. Nowadays, the man who finds the wool, the clay, the cotton, or the wood, or buys the machinery, or packs the goods, or carries them, or what not, gets all the advantage, and he who confers its value on the article almost nothing. I heard of a designer who sold for three guineas a design that took. The manufacturer gave up the manufacture of everything but that article for some years, and probably made his fortune, but he never gave the designer an extra sixpence. I think the leading idea of many manufacturers is how to steal a design. Had not Carlyle got some able man to negociate for him he would have died a pauper, and all the profit of his works would have gone to the publisher.

Almost all our best patterns have come from the East, and I know that there the designer is highly paid, and gets a heavy royalty on every piece that is woven or embroidered from his design.

In the story of Alee-shér and Zumurrud, Zumurrud had probably learned the design by heart, but the embroidering alone was well paid for. She gives Alee three pieces of gold to get their food and drink for the day, and for a piece of silk, and she directs him to get "as much as will suffice for a curtain, and buy gold and silver thread and silk of seven different colours . . . . . . The damsel took the curtain, and embroidered it with coloured silks, and ornamented it with gold and silver thread; she worked a border to it with the figures of birds, and represented around it the figures of wild beasts, and there was not a wild beast in the world that she omitted to pourtray upon it. She continued working upon it for eight days, and when it was finished she cut it, and glazed it, and gave it to her master, saying, 'Sell it for fifty pieces of gold.'" If we allow two pieces for the stuff, the silks, and gold and silver thread, she got six pieces of gold a day. Even if we took gold at its present value, though it has enormously diminished in value, it is three guineas a day, which cannot be considered a bad professional income for an embroideress, even if she furnished the design.

There is one more subject I want to touch on, the value of old work; the older the work is, as a rule, the more likely is it to be good, for the less good things have perished by the way. Someone illustrated this effect of time by comparing it to a man who went to settle in the backwoods with a large library, the farther he got from the tracks of civilisation the harder and more expensive he found it to carry many books, so he gradually threw them away, till on his arrival at his destination he had only half-a-dozen, and these, of course, were those he considered the most perfect, and which he set the most store by. Each epoch that had high aims, superior people with great skill in their art, much competition and able critics, naturally produced the best works; in after times those who practised the same art highly valued work that was better than they could do.

That which is the most perfect in ornament is the work of people gifted with high artistic fibre, and faultless execution, to whom Nature appeals in her masterpieces, who assimilate some of the matchless grace they see in a flower, in the turn of a leaf, in the curves that mark the growth of a creeper, in the wing of a bird, the curve of a lizard, or the knots or spirals of a serpent, who can so arrange these forms as to perfectly satisfy the cultivated eye, and keep them subordinated to the containing lines; such things may be seen in examples of Greek and Tuscan, or rather North Italian, ornament. This sort of ornament by some mishap has got christened *Conventional*, which has no meaning as applied to ornament, and should rather be called *Abstracted*.

Colour is another species of ornament that, like form, has doubtless its laws, though, as yet, neither have been discovered, and we call form and colour, like medicine, empirical arts We observe that the collocation of certain spaces, or masses of certain colours, give us more pleasure than others, and we try and

recollect these collocations if we deal in colour, and use them when we have occasion.

It has been observed that the primaries that are complementary—*i.e.*, whose mixture produces white—go well together, and that certain secondaries and tertiaries set off primary colours. Chevreul found that the saturation of the eye with a colour caused it to see the complementary colour if a white surface was looked on. Everyone knows this from Pears' advertisements. And Chevreul also found out that if we looked at another colour, it was modified by the complementary colour of the first. He wrote a long book about it, mainly consisting of examples of this one observation.

There is little else to say, except that when a full or deep scheme of colour is settled on, white must be used sparingly, like a jewel, and that when a light scheme is used, black has the same value, and that all pure colours, if used on a white or very light ground, must be pulverised, *i.e.*, used in minute particles, or very light tones only be adopted. Aristotle remarks (Politics, Lib. 4, cap. 7) that the inhabitants of Europe, "while full of spirit are comparatively deficient in intelligence and artistic skill;" while "the nations of Asia, on the other hand, although intellectual and artistic, are wanting in spirit." This is still true for colour only, for the reproduction or invention of exquisite form is now the prerogative of Europe, and of those Europeans who have colonised other parts of the globe. The products of Asiatic looms and potteries are to be studied for magnificence, beauty, and exquisiteness of colour, as well as the works of nature. As a penance it may occasionally do us good to be surrounded with ugly forms and discordant colours, to pass an hour or two in the parrot house of the Zoological Gardens, to cover ourselves with ashes, and to eat nauseous food. But to condemn ourselves to this perpetually is not to acquire virtue, but to brutalise ourselves, and to throw away the good gifts the Almighty has provided for us.

Miscellaneous.

MARINE BIOLOGICAL LABORATORY.

On Saturday last, the 1st inst., the Marine Biological Laboratory, which has been built at Plymouth, was formally opened. In 1885, a paper advocating the formation of such an institution, and pointing out the important effect it might have upon our supply of fish for food, was read by Professor E. Ray Lankester, before the Society of Arts. On that occasion Mr. E. L. Beckwith, then Prime Warden of the Fishmongers' Company, was in the chair. The attention of the Court of the Company was thus drawn to the movement, and the result was that the Company contributed largely to the necessary funds, thus enabling the proposals for which Professors Lankester and Moseley are mainly responsible to be carried into effect. The building which was opened on Saturday cost £12,500. On the ground floor are a series of tanks, above this is the laboratory proper; this consists of a large room divided by partitions into small workshops. Each of these small chambers is fitted up with water supply, a sink, a bench, and other appliances necessary for carrying on the work. In the centre of the room are a series of small tanks in which animals under observation may be kept. Above this again is the library. In the basement are engines by which the water is kept circulating through the tanks, and also through a large reservoir at the back of the building. There are two of these reservoirs, each capable of holding 8,000 gallons; one being for use while the other is being cleaned, or serving as a settling-tank. The water is drawn from a point some distance out from the shore, and is forced up to the reservoir by a Shone's ejector. The site of the building is at the eastern end of the Hoe, between the old citadel of Plymouth and the edge of the cliff. The actual funds at the command of the committee of the institution amount to between £16,000 and £17,000, of which, as above stated, £12,500 has been spent on the building. They have also an annual grant from the Government of £500. The site for the building has been granted free of charge by the War-office.

DAIRY PRODUCTS OF THE UNITED STATES.

Consul Hayes Sadler, of Chicago, in his last report to the Foreign Office, says that the magnitude of the dairy interests in the prairie States, which is continually on the increase, cannot be shown without the statement of a few facts. On January 1st, 1887, there were 1,243,000 milch cows in the State of Iowa, 937,476 in Illinois, 729,959 in Missouri, 60,960 in Kansas, 548,222 in Wisconsin, 417,275 in Minnesota, and 333,836 in Nebraska, making a total in these seven States of 4,819,371 milch cows, besides 8,836,016 other cattle. Statistics are wanting to show the exact quantity of butter and cheese made, but Iowa alone produced 86,000,000 lbs. of butter, and the produce of its dairy farms sold outside the State is estimated at £4,200,000 for the year 1887. Minnesota produced 40,000,000 lbs. of butter, and the other States may be calculated to have produced comparatively, according to the number of cows

while with the rich fertile soil their capabilities are many times the present produce. Chicago handles to a great extent the shipments of the north-west; in 1887 the receipts were estimated at 127,750,000 lbs. of butter, and the shipments at 116,500,000 lbs. The cheese receipts were 46,425,000 lbs., and the shipments 42,000,000 lbs. Direct exports from Chicago are small, and amounted last year to 500,000 lbs. of butter, and 2,400,000 lbs. of cheese. By far the greater part is made at creameries and factories, which are largely increasing in number. Dairy interests have largely suffered from the manufacture of oleomargarine, butterine, and other products of animal fat, which, though excluded by recent legislation from entering into the manufacture of butter, injure the genuine article by force of competition, and still enter largely into the composition of cheese, little of which is comparatively consumed in the country, as so little good appears to be made. It is stated that in the last few years the dairy industry has not made the advance it should, had fraud not been practised on its product, but that during the last year, as a result of the Oleomargarine Act, butter has very generally improved about 2d. per lb., and that there is now a great demand for churn apparatus. Most of the States have local laws, either prohibiting or controlling the sale of oleomargarine, and the adulteration of the products of milk, but they are for the most part inoperative, and it is said that dairy associations would gladly welcome further Federal legislation.

Correspondence.

MANUAL INSTRUCTION OF THE SCHOOL BOARD.

I beg to state my view of the advances displayed in the exhibition by the London School Board at the Albert-hall, on Friday, the 29th ult., in the annual competition for our banner, to which has been added a competition for another banner given for school drill to girls by Mr. Helby, a member of the Board. In the first competitions for our banner the boys presented rather a sorry appearance; many of them were very pallid and few well dressed. On this occasion it appeared to me that the competitors presented a very great improvement. They looked healthier, which I hope may be due to the advances made in the sanitation of their homes; the boys, moreover, were generally well dressed and well set up. One result of our pressure on the Department was to obtain pay for the teaching of military drill in schools, which led to its adoption in upwards of 1,000 of the largest schools throughout the country. But there is drill and drill. The non-commissioned officers who generally acted throughout the country as drill masters had a system of inferior character to that now introduced into the army. The importance of the need of manual as well as mental training is now extensively perceived by both Houses of Parliament. The gymnastics exhibited in the Albert-hall on Friday last were the most successful of any that I have witnessed, and showed what may be done with them for industrial as well as for sanitary purposes. It is to be noted, however, that Sweden still maintains an advance in this respect. At Stockholm, any child on admission to school is now diagnosed by an expert, who marks any bodily defect and prescribes the special remedy for it. It is important to have made known for how many defects cures by special gymnastics are available. The expert at Stockholm prescribes the special remedies and leaves it, not to the schoolmaster, but to a subordinate specialist, to see to their proper application. This child may have a contracted chest and a predisposition to heart disease; the prescription would be for an additional dose of the exercises calculated to expand the chest. Of the candidates as recruits for the army with us, more than 400 in 1,000 have been, on examination, pronounced unfit for service; of these defects a large proportion would be removed by special physical exercises. It is to be hoped that similar provision may be made in England. An application was made by myself a long time ago to the Charity Commissioners for a portion of their funds for providing a training college for physical exercises. It is to be hoped that Mr. Longley, the Chief Commissioner, will bear this in mind. The female exercises, which were chiefly Swedish, appeared to be new, and to be a great advance upon anything that has been done before by the School Board. The girls looked extremely healthy, and were nicely dressed in the distinctive costumes of their different schools—blue, red, and yellow scarves, &c. The effect was particularly attractive and picturesque. The concourse of girls presented the appearance of a great bed of variegated flowers. The smallest children—the little tots—seemingly took a lively interest in their own work as well as in the work of others, and their applause of the successful work of the boys was quite inspiriting. The singing of both boys and girls seemed to me to admit of improvement up to the point of the boys at the Royal Military Asylum, Chelsea. The whole effect, however, was most admirable, and the School Board may be congratulated upon it, as well as the teachers of Bellenden-road School, Peckham (boys), and Surrey-lane School, Battersea (girls), respectively, the winners of the banners. The example cannot fail to tell upon our provincial cities and towns. Amongst other results it may be expected to make an advance in the great sanitary factor of personal cleanliness—head to foot washing with tepid water, such as they have in the best schools in Holland, and such as we now have in our best district schools, with so large a reduction of infant mortality. To the School

Board may be commended attention to proper provisions for that purpose, as well as for efficient ventilation with air that is warmed and pure in winter, of which there is as yet great defect in the schools. I cannot help feeling what a pleasure it would have been had our colleague, the late Sir Henry Cole, been spared to witness the exhibition of Friday last, and see its promise.

EDWIN CHADWICK.

East Sheen, S.W., July 2, 1888.

LOCKS AND SAFES.

I notice that in the paper read by Mr. Chatwood before the Society on the above subject at a meeting on May 9th, he stated that the earliest record he could find of a patent T-girder applied to safes was in 1865. Quite true; it was our Mr. Noake's invention. But Mr. Chatwood will not deny that my firm was using for some years before the date of his patent—viz., 1862—a T-girder with the overlapping edge, or that our Mr. Noake was the inventor of steel and iron rolled together for the use of safe makers.

For eight years before any firm used steel and iron hardened, and placed between two plates of soft iron, my firm was quietly making and selling safes made on both the above principles.

HENRY A. HARPER

(Messrs. Thos. Perry and Son, Limited).

TOBACCO.

Mr. JOHN COLLINS (Bolton-le-Moors) writes:—The following reply of the Chancellor of the Exchequer in the House of Commons is worth placing on record in the pages of the *Journal.*

"Mr. Crilly asked the Chancellor of the Exchequer whether he would cause an inquiry by experts into the results attending the experiment made by Messrs. Cope in the manufacture of an extensive crop of English tobacco grown by Messrs. Carter and Co., with the view, if possible, of relaxing the fiscal restrictions upon the culture of tobacco in Great Britain and Ireland.

"The Chancellor of the Exchequer said, in reply, the experiment referred to consisted of the manufacture of cut tobacco and English-grown tobacco by Messrs. Carter and Co. Great care seems to have been exercised in the manufacture of the article, but from information he had received, he believed that the results had not been very satisfactory. Some of the tobacco sent to him seemed to be deficient in flavour and in character; but he should be sorry to use any words which would discourage the experiment being tried. He thought it was an experiment which would show English smokers the value of the tobacco. An inquiry by experts would not be so valuable as a practical test by hon. members accustomed to smoking; and if hon. members wished, a sample of the tobacco would be placed in the smoking room. The fiscal regulations were not unnecessarily stringent. He would be anxious to facilitate the progress of the experiment, but the growth of tobacco was so large a matter that it was impossible to relax the fiscal regulations without risking serious loss to the revenue."

Mr. Collins adds:—From *Le Courrier de L'Europe* of the 9th inst. I give the following paragraph, which has a peculiar bearing on the subject:—

"Le *Paper Makers' Circular* dit qu'une usine de l'Etat de New York fabrique de grandes quantités de papier dont la destination avouée est d'être transformé en tabac. Il paraît que les *honnêtes* industriels qui opèrent cette transformation trempent à plusieurs reprises le papier dans une forte décoction de tabac; ensuite ils le découpent et le pressent dans des moules qui donnent à chaque feuille les nervures que possèdent les véritables feuilles de tabac. L'imitation est si parfaite que des connaisseurs en tabac et des fumeurs s'y sont trompés. On a fait circuler dans une société des cigares fabriqués avec ce tabac, et ils ont été déclarés excellents: beaucoup de personnes ont affirmé qu'ils étaient de marques peu communes, et l'imitation était si parfaite qu'un amateur assura qu'il ne pouvait y avoir aucun doute sur leur origine."

General Notes.

PATENTS AMENDMENT BILL. — The Bill to amend the Patents Acts, 1883, introduced on behalf of the Government in the House of Lords by the Earl of Onslow, has been printed. Its principal provision relates to the registration of patent agents. It proposes that after the 1st of July, 1889, no person shall be allowed to describe himself as a patent agent, under a penalty not exceeding £20, unless he is registered under the Board of Trade. Any person who can show that he has been practising for twelve months before the 1st of the present month as a patent agent is entitled to registration. Future registrations will be made under rules to be prepared by the Board of Trade. The other alterations proposed refer for the most part to details of the method of procedure.

STREET RAILROADS.—The growth of street railroads in the United States and Canada has been very large of late, 1,198 miles of new track being added in 1887. The number of miles already decided upon to be laid in 1888 is 1,121, at an estimated cost of £2,000,000. The number of cars to be added this year will be 2,634, which alone will cost £370,000. The roads will require 21,570 horses, to cost nearly as much as the cars. Last year the cost of improvements, including stables, was £720,000, and the estimate for this year reaches £3,060,000. This large amount is said to be owing to the substitution of extensive plants for cable and electrical traction in place of horse-power.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, the 9th inst., at their first meeting after the annual election, the Council elected the Duke of Abercorn, C.B., as Chairman for the ensuing year. The various committees were also re-appointed.

Proceedings of the Society.

CANTOR LECTURES.

DECORATION.

By Professor G. Aitchison, A.R.A.

Lecture II.—Delivered May 7, 1888.

I touched on some of the motives of decoration in my former lecture, but I did not say that in using decoration we are strictly following Nature, who not only makes most of her works of beautiful form and of beautiful colour, but enriches them with a variety of texture, of patterns, and of colours that would in man's work be most strictly decoration. No doubt some of this is protective, but much also, as far as we can judge, is for purely ornamental purposes—*i.e.*, to please the other animals that look at them, including man. To illustrate purely protective colours and forms which, to man at least, are not beautiful, I may instance the turbot, which is greyish brown above and white below, so that its enemies cannot see it on the grey sandy flats when it is asleep, nor can they easily distinguish it from the water when it is floating overhead. The plaice, too, has much the same colour, only varied with red spots, as it lies on pebbly or shingly bottoms. The silver mackerel, with its green and black bars, may be so ornamented for protective purposes, but, as far as we know, these forms and colours are only for beauty, and we do know that these markings struck the New Zealanders as the most beautiful ornament they had ever seen, and so they tattooed themselves in patterns to imitate it. These few facts are interesting, and give us an insight almost unique into early motives and methods. In this case the New Zealander was deeply struck with this naturalistic ornamentation of the mackerel; he thought it the most beautiful thing he had ever seen, and appreciated the additional beauty it conferred on the fish. The man, being a reasoning animal, says to himself, "Why should I not enhance my beauty in the same way?" But, being a savage, he cannot copy, he can only invent. A civilised man, animated by the same desire, would have imitated the markings; the savage, with these markings in his mind, puts lines on his face on the same principle, *i.e.*, to adorn it; and if you look at the tattooed face and compare it with the mackerel bars, you must say that the tattooing is a very conventional way of representing it. The *anthemion*, or Greek honeysuckle, seems also to have been a tattooed pattern in imitation of flowers; so you see that the New Zealander and the early Greek were both actuated by the same motive, only they admired different types.

The eyes of the wings of butterflies are said also to be protective, but I presume their other spots and variegations are for beauty only, and protective decoration can hardly include the patterns on the silver pheasant, the plumage of the humming bird, or the peacock; while one can hardly fancy that it applies to the spottings, veinings, and variegations of flowers, whose only use seems to be to please the eye of insects, and of man.

In my former lecture I said decoration was purely painters' or sculptors' work, but I then referred to animal or vegetable forms. The gift of harmonising colours may belong equally to the painter and the architect.

The schemes for decoration are purely architectural, not only when they apply to buildings but also in the case of separate articles that are moveable, and that are not wholly covered with one scheme of ornament, and for this reason, that architecture deals with harmonic

proportions, and with the contrast of primitive forms. We are all entranced with the sublime conception and magnificent execution of Michael Angelo's frescoes in the Sistine Chapel, but no architect can help being shocked at his utter disregard of the chapel itself; the scale of the decoration utterly destroys the size of the chapel. Whether the ornament be painted or sculptured figures, landscape, floral design, or formal ornament, the most important thing is to make the whole look well and appropriate for its purpose. One of the great arts of the decorator is to arrange his spaces harmonically, with due consideration for the use of the object, and occasionally to cure defects in the floors, walls, or ceilings of a building, when the proportions are not all that can be wished.

To take a room for example; if it be too low to admit of figures being of an adequate size to be seen, they must be excluded, and even if there be plenty of height, we do not want the figures of such gigantic size that a fine room is dwarfed into a doll's house. Certain parts of a room, too, are better seen than other parts, and it is useless to put elaborate decoration on parts that are mostly hidden by pieces of furniture, or which one must go down on one's knees to see; we do not want a floor so decorated that it looks painful to walk on, or so ornamented that we think we may trip over the things portrayed; and I may say that perhaps the very worst fault ornament can have is a look of winking at you, or being in movement.

In choosing colour, again, we should be careful to have such a tone that we can live with, for most people have their dislikes and preferences. The colour of a lady's boudoir is mostly chosen because it sets off her complexion. In a room where we work we are soon conscious of an objectionable colour which irritates instead of soothing us. Certain colours and certain tones are beneficial or prejudicial to health; very dark rooms are prejudicial, and red or yellow will also have a prejudicial effect on our health, if we have to remain in rooms of either colour all day and every day. A manufacturer had a women's workshop painted yellow, and found much more than the usual sickness amongst his hands; his doctor recommended whitewash, and the normal health was restored. Growers of hyacinths have noticed a marked effect on their blowing when they are put in glasses of certain colours.

If these lectures were a series on the history of decoration, it might be well to begin with its first application to the body of the naked savage, to his implements and weapons, to his clothes and habitation, and finish with the purely decorative articles of wear; but I think we more want some hints of how to use the ornamental and ornamented materials we have at hand, and what improvements can be suggested in them and in their application.

As far as I can see, the most important thing for Londoners is to know what they have at hand for the exterior decorations of their houses, and religious and public buildings, then what is, or can be, used for their internal adornment, and, if there is space and time, to hear of those things which form the decorative accessories of the people and their buildings.

This age is a peculiarly health-seeking one, and it does not seek health, as the Greeks did, by early rising, temperance, open-air exercise, and training; but it asks how health can be preserved and promoted by the removal of external sources of disease, so that it may have freedom to infringe with comparative impunity Nature's laws. If the Legislature sets the example of turning night into day, by sitting up nearly all night and beginning work at noon, those that are in its service must do the same, and the families of its members are almost compelled to do likewise. Members, too, as a rule, suffer from want of sleep. We have only to look at their cadaverous faces, their worn and exhausted air at the end of the session, to see how injurious this is to health. We must expect, too, that all the less exalted members of society who have a chance will do the same, but by doing so they lose a great deal of daylight, and the stimulation of the sun and daylight air, for night air is said to contain more carbonic acid gas; and besides, if nature intended us to sleep at night, it is hardly likely we can contravene the law and be equally well and strong.

External poisons are the most important things to protect ourselves from, especially when we have enfeebled our bodies, and these are mostly conveyed to us by mephitic vapours, and what the doctors call septic dust; we want our houses and other buildings so constructed that they can be freed outside from their palls of dust and soot by means of a fire-engine or a sponge, and inside by the broom, the dusters, and the flannels of the housemaid.

Foul and poisonous air has scarcely any connection with decoration, but, with one or two exceptions, is in relation with pure science

and its applications. The exceptions are when some of the materials used for decoration have a pernicious chemical action on the air, or parts of their substance readily come off, and poison us when breathed, or when in contact with our skin. The former is said to be the case when preparations of arsenic and some other dyes and pigments are used, and are not varnished.

The dust that is not septic consists of minute particles of raw or cooked earth, stone, and metal, and the ill-effect it may produce can only be from irritation of the mucous surfaces, by clogging fine vessels, or by getting into parts where it is not wanted; particles of some metals, if numerous enough, may poison us, as fire gilders are poisoned by mercurial fumes.

The septic dust consists of particles of vegetable or animal fibre, sometimes laden with the germs of disease, the pollen of flowers, by some of which hay fever is said to be produced, the minute seeds of plants, including fungi, the eggs of microscopic creatures, and microscopic creatures themselves.

If we think for a moment that dough, after a short exposure, rises, and that fermentable liquids ferment, we must acknowledge the almost universal prevalence of germs in the air; for I believe both fermentations are owing to plant growth, not to speak of exposed distilled water being shortly full of microscopic animals and vegetables.

There is still another source of poisoning, *i.e.*, by human and animal exhalations, including our own; these are said to be absorbed by certain substances in an odd way; dry wood, vegetable fibre, and silk are said to mainly absorb the foul smelling exhalations, while wool, hair, and feathers mainly absorb the perfumed ones.

Anything that forms a dust-trap is as far as possible to be avoided, particularly when these traps can only be partially emptied at long intervals, for every breath of air dislodges some of the lighter particles. The absorbents of the foul smelling exhalations have also the property of imparting them to damp air, by which we are poisoned or re-poisoned. Consequently, we want to avoid as much as possible all woven and felted stuffs in our houses, and have all wood and paper protected by varnish.

Bear with me if I diverge a moment from philanthropic motives. At present mankind seem oblivious of the fact that they must breathe pure air to be well. For their supply of air they mostly trust to imperfection of workmanship, the porousness of materials, and to the smoky or soot-polluted air that comes down the chimney, and to the same exit for the foul air, although it is mostly below their mouths when they stand upright. To anyone who is aware of this necessity for pure air, the sight of a room with no appliance for the entrance of fresh air, or the exit of foul, causes a shudder for the loss of present comfort and the future gain of a headache, particularly when there is a party and the weather is cold. From 40 to 200 people are commonly massed in a room for hours that has not pure air enough for two people, and that usually has lights enough in it to alone make it unfit for respiration. Yet you may take my word for it as an architect that not one man in a hundred will hear of ventilation. He usually says, when pressed, "I want no ventilating conundrums; if the rooms are too close I will open the door, and if that is not enough I will open the window."

Few of us can expect to live in houses built of polished granite, porphyry, and jasper, and adorned with precious stones, but we may expect to live in those protected and embellished with enamelled terra-cotta, glass slabs, or glass mosaic, and that our streets may at least present us with a clean, gay, and cheerful appearance, even if they do not quite realise M. Charles Garnier's dream of a transformed Paris:—

"I imagine the day when the tawny tones of gold will pick out the monuments and construction of our Paris; I imagine the warm and harmonious tones that will tremble under the delighted gaze. One will then have renounced those grand straight-lined streets, beautiful no doubt, but cold and unnatural as the ceremony of a noble dowager. The inflexible Commission of Ways will have its period of reaction, and without anyone being hurt, everyone will be allowed to build his house without making it match those of his neighbours; the grounds of cornices will shine with eternal colours, the piers will be enriched with glittering panels, and the gilded friezes will run the whole length of the buildings, the buildings themselves will be clothed in marble and enamel, mosaic will make everyone love sparkle and colour. This will not be false and petty luxury, it will be opulence, it will be sincerity. The eye, familiarised with all the marvels of tints and splendours of colour, will insist that our dress shall be modified and coloured in its turn, and the entire city will have an harmonious reflection of silk and gold. But, alas! I look around me. I see a grey and sombre sky, I see newly-painted houses, I see the shadows quite black, that wave in the interminable boulevards, I see, in short, Paris as it is!

And from my artist dream I fall again into vulgar reality."

This dream is by no means impossible. I may tell you that when I was at Berlin a good many years ago, I saw a mansion that the Italians would call a palace, wholly covered with a facing of compressed tiles in patterns, the dressings of the windows and the oriels wholly composed of Minton's majolica, with a glass mosaic frieze, adorned with subjects in colour on a gold ground. I could not help saying to myself, "Here is a palace adorned with coloured materials, all but the mosaic certainly of English manufacture, but we at home have neither the taste nor wit to use them." It is true that most of our majolica leaves much to be desired in beauty of shape, in quality, tone, and arrangement of colour; but these defects could be amended if there were demand enough for skilful architects, designers, and colourists. Enamelled pottery does not do well as a rule with dull granulated surfaces. Even when new it requires a very able architect to use it properly, and in London it becomes staring, as the rough material is blackened by soot. Where granulated surfaces must be used, enamelled pottery might still be applied in very small pieces to give value to the colours of the main materials, just as nature colours a pistil, a stamen, or a spot with one complementary primary to set off another, or a secondary, or a tertiary.

There is in Oxford-street an eating or coffee-house wholly fronted with enamelled pottery that is absolutely unimpeachable, only the architect or the owner had the fear of fools upon him, and declined to give us splendour or gaiety.

I beg you to observe the Chinese, Japanese, and Persian pottery exhibited, mostly in the shape of tiles, and I ask you if these would not make a lovely alternative to our present fronts of dingy brick or plain or painted compo. When I was in Cairo, many house fronts and some fronts of mosques were faced with these Persian or Rhodian tiles.

If any one would start a gorgeous front of enamelled pottery there would be an outcry at first; but we should gradually get accustomed to beauty and colour, and get reconciled to the loss of dingy and blackened brick. Even now there is no outcry when the platforms of a railway station are lined with white glazed bricks banded with green or grey, and the small extra cost would soon be repaid by better health and the saving of painting. At first this could only be done by tasteful, benevolent, and patriotic men who were wealthy, or by enterprising ones, who thought a house so fronted would advertise itself; but as this sort of facing came into fashion—as it certainly would—window jambs and reveals, panels, strings, and cornices would be kept in stock, probably printed in colours instead of hand-painted, and would be cheap enough. The gorgeous colours of the Persian tiles are now rivalled by De Morgan, who has, too, rediscovered the crimson metallic glaze of Maestro Giorgio, and he could design, paint, and burn a brick as well as a tile or a pot.

There is one use of enamelled pottery I have not mentioned, roofing tiles. In parts of France and Italy these prevail. At Lugo, in the Romagna, I saw the steeple of a church covered with enamelled pottery of different colours, which wound round it, the steeple being a cone; the visible glazed parts were semi-circular in section, and though I do not know how they were fixed, they looked as if they were stuck into mortar, like the enamelled terra-cotta cones found at Babylon, and used to ornament wall surfaces. Most of the tile patterns I have seen in France are, to say the least, more ingenious than beautiful; but there are gold and green tiles used at Vienna and at Botzen that are ornamental enough, and the Chinese glazed yellow tiles seem to look well in the drawings of Chinese buildings.

Even the Romans were more alive to the use that might be made of broken glass than we are, for we learn from Martial that the collection of broken glass was a trade, and the glass, he says, was exchanged for brimstone matches. Some believe it was treated with sulphur and cast (I presume into slabs), mostly made to imitate agate, jasper, lapis lazuli, or some precious stone, and used for pavements, wall linings, and the like. It probably was from such slabs that the glass mosaic was first chipped off. We know from Pliny the elder that glass was used by Scaurus for the decoration of one storey of his temporary theatre, and it is conjectured that this glass was the cast slabs before mentioned.

I cannot say how these glass slabs or tiles would stand our climate, but if they could be fixed in no other way, they might be set in frames of cast iron, barffed. Many of you probably know how glass mosaic is made; generally the colour pervades the whole thickness of the glass, the glass is cut into strips, and is then roughly chipped off into cubes; the best mosaic was chipped into very small cubes, from 3 to 5-16ths of an inch square,

but the commoner sort is from 3 to 5-8ths; the metallic glass mosaic consists of a leaf of red, yellow, or green gold, or of silver, laid on to a glass body, then covered with a thin coat of glass, and the two fused together. You may see, in the Early Christian glass medallions, the gold leaf attached to the lower glass, etched into heads of holy personages, Christian stories or symbols, and then a thin coat of transparent glass fused on.

In the modern Roman gold mosaic, the body is of opaque red glass, but in the Venetian, Sicilian, and Oriental varieties, the backing is of transparent glass, often of a greenish hue, which is much less hot in appearance than the other, for the gold rarely fills the whole field, and the glass beyond it shows.

Some of the cubes exhibited, technically called tesseræ, are from La Martorana, at Palermo, and some from the Mosque of Omar, at Jerusalem, the latter presented me by Sir F. Leighton. It is believed that the mosaic of the latter was executed in Constantinople, for even as late as the 8th century (and Omar was assassinated before the middle of the 7th), the Caliph Waled I., in his treaty of peace with the Roman Emperor at Byzantum, stipulated for mosaic to be supplied by him, for the decoration of the mosque at Damascus. The word mosaic comes from "Opus Musivum" —work of the Muses—or, as we should say, artistic work. At present the Mosaicists are very far from deserving the name of artists, or being classed with the Maîtres Mosaistes of George Sand. The artist who designs and colours the cartoons has to mark on his designs every tessera to be used; the mechanic fits these according to the shape or colour from trays containing the different colours, and the whole is pasted on to brown paper, which is cut into short lengths, rolled up, and sent here from Venice—at least, up to a late date, Venice was the seat of the manufacture both of the raw material and the finished work—then unrolled, pressed into the mortar, called *mastic*, the paper washed off, and the mosaic driven in with wooden malls. If we are ever to have work of the highest excellence the mosaic worker should put his own lines on the cartoon, *i.e.*, translate it as he works it, and arrange the tints, so as to get the effect the artist shows, and should be skilful enough to re-do such parts as require it in place; the exact effect can never be known until it is fixed. If the mosaic workers were good enough to do this, and were properly paid for their skill, we should soon have artists who worked wholly in mosaic, who would know how the effect wanted was to be obtained. You must recollect that in church work, and in large public buildings, the mosaic is generally at a great height from the eye, and more often than not, inside a dome, a half-dome, or a vault; these curved surfaces have their own lights and shades, and even at a great height the colours required are often better produced by the intermixture of tessaræ of pure colour than by matching the exact colour of each tessara in the cartoon. Perhaps the most lovely coloured mosaics that exist are at St. Vitale, and in the tomb of Galla Placidia, at Ravenna, executed in the time of Justinian; that in the tomb of Galla Placidia has a blue ground like a peacock's neck, and is ornamented with gold ornament. In the half-domes of apses, where very old work exists, we are often surprised at its superiority in tone to new work, which often looks like painting on a brass basin, and it is not until the half dome is reached by a ladder, that you find out the reason. In modern work the mastic is flush with the mosaic, but in old work very long slips of glass mosaic were used instead of the ordinary tesseræ, and only held at the end by the mastic, so that there is shadow all round them. The gorgeousness of colour obtained by this material can only be judged of at Rome, Venice, and Ravenna, near home, though I believe there are still finer specimens at Constantinople, Damascus, and Jerusalem. Very ingenious parodies of pictures can be made with mosaic. If they will stand a fire they might be valuable by preserving the form, and a notion of the colour of the masterpieces of great artists. Raphael's "Transfiguration" in St. Peter's at Rome is the most celebrated of these. They were mostly used for ornamenting the gold and silver gilt covers of books, and now for ornamenting jewellery, and are said to be set in wax. When smooth they are not very effective, though when the surface is left rough, they tell as colour very fairly. For internal work mosaic pictures composed of tesseræ of marble or pottery answer, but wholly lack the gorgeousness of glass mosaic. Mosaic for pavements I reserve for another place.

I hardly know if I should include sgraffito. It would certainly be useless in the denser parts of London, as it would soon be a uniform dingy black; but we know that there are still examples that are visible at South Kensington, and that it lasts well in the country.

It is done in this way:—Any coloured

ground that may be chosen is first prepared of mortar or cement, coloured with earthy or mineral pigments; it is then laid on the wall. White, black, yellow, red, or grey are the usual colours. On one of these grounds before it is dry about one-eighth of an inch of cement of one of the other colours is laid, the pattern is pounced on, and the parts outside the pouncing are scraped off with a modelling tool, a knife, or a bit of stick. When the whole has set, you have a picture or a pattern in two colours. This sort of work has stood in England for over twenty years when executed in the country, and in Italy the whole fronts of many large palaces have been adorned in this way, and have stood for centuries.

Public buildings built of polished marble, granite, porphyry, jasper, agate, or onyx, or faced with these, are sometimes ornamented by inlaying pictures or patterns with coloured marble or precious stones, but I do not know of any external example in England. This work is called *pietra dura*. The Taj Mahal in India is a celebrated example. There are plenty of slabs, basins, vases, paper-weights, and jewellery imported from India and Italy of *pietra dura* work.

All external work in calcareous marbles soon perishes in the atmosphere of London, whether plain or inlaid, and all incised work filled with mastic so soon gets blackened that to execute it is merely labour lost. The only other work that can be used externally is in metal. Iron rusts unless constantly painted, and almost all other metals turn black. An insurance office in the Poultry was covered with copper scales that flamed in the sun, but after a few months' exposure they became as black as ink, and what does not oxydise to blackness is covered with a black pall of soot; bronze gets nearly as black as copper, but it has of course a slight diversity of hue. Real block tin, not tinned iron, is said to stand the climate of London, but of course does not lack its pall of soot. Iron plates tinned are much used in Switzerland for the covering of steeples, but even there they get rusty. Lead takes its own blackish grey, but as it otherwise stands the climate well, I wonder it is not more used for ornamental purposes, as vases, statues, roof-crestings, and the like. When I was a boy, some plumbers' shops were ornamented with leaden statues, vases, and ornamental cistern fronts. Lead is still used for ornamental roof-crestings in France, often heightened by gold, black varnish, and colour. Lead is still much used for ornamental accessories in Holland—or perhaps I ought to say, was once used. I only know that there were many such when I went there in my youth; and they were much used over here during William the Third's reign. Up to a short time ago there were leaden statues and vases in the gardens of the stately mansions in Mark-lane, near the Tower of London; there are still some at Hampton Court, and they would do very well in the niches or on the pedestals of our red brick fronts, if we could not afford bronze.

It is unnecessary to speak of the ordinary freestones that weather in London, such as Portland, Chilmark, Tisbury, the sandstones, red Mansfield, and Dundee, which we all know; nor brick, both cut and moulded, nor red, yellow, or grey terra cotta, for all these have more or less granulated surfaces that can only be cleaned by tooling or rubbing, but plaster has never of late, as far as I know, been even tried, I mean plaster of common sand and lime, or, what is still better, of lime and marble dust. Vitruvius tells us that old Roman walls covered with this material were so hard, so beautiful, and so finely polished, that in his time slabs of it were cut out and used for table tops. In speaking of plaster, I did not mean compo, either Roman, Portland, or mastic, but that plaster that is made workable for modelling, which the Italians call "gesso duro." It was once common in England; the "Peter Pindar," in Bishopsgate, is an example, or was an example a few years ago, and many admirable specimens still exist in our country towns. Some of the vaulted ceilings of Hadrian's villa, at Tivoli, now open to the air, are still adorned with it, the grace, freedom, and delicacy of whose modelling we still admire, although it was done at least 1700 years ago. In few things has England declined more than in plastering, from the prevalence of casting, which allows the employment of the least skilled mechanic. Most of us have seen the magnificent ceilings of Elizabeth, James, and Charles the First's time, on whose flowers, fruit, &c., you can even now see the grain of the plasterer's hand, and the holes made by his thumb to get shadow. Even in plastered ceilings of Sir W. Chambers's time, who died in 1796, you see beautiful work in high relief of fruit, flowers, and foliage, and I believe the skill did not die out completely till the end of the first quarter of this century. Not twenty years ago a clerk of the works offered to reveal the secret of "gesso duro" to me if he were given the job of executing by stamps some

embossed plaster work I had to do, but the owner of the house would not go to the expense, so cast slabs were used, and the clerk of the works said the secret he had learnt from an Irish plasterer should die with him. The infinite variety that hand-stamping produces, would to refined tastes be worth the expense, for cast work is all alike. In the case before mentioned, to have introduced intentional variety would have been even more costly than stamping.

It is highly benevolent to encourage skilled handwork, for you not only liberate the better sort from that mechanical work, which frets and eventually destroys a man by its unvarying and unthinking monotony, but you encourage higher skill, and you allow a man to put his soul instead of his fingers into the work. I speak most feelingly on this subject, for after my return from Italy I was in an office as draughtsman, and there I was compelled, as was then the custom, to ink in large and elaborate drawings, where a little attention, some rapidity, and close application were alone required, I regretted I was not closing boots. I could have got a certain satisfaction from thinking I was saving some from colds and wet feet, while my work was of no use to anyone.

Do not suppose I am finding fault with those excellent materials, Roman and Portland cement, or even mastic; all I mean is that, as yet, we have found no way of using them ornamentally in London, except as imitation of stone and stone carving. If we had a pure atmosphere, the two first would be invaluable for inlaying, but in a very short time stone and inlay are indistinguishable from the general grime, and that too even when the inlay is black mastic.

At the Alhambra, Granada, the plaster work seems to have been carved by hand. You still see uncarved patterns with the spacing marked out by sunk lines.*

The late water-colour artist, Mr. Lundgreen, once described to me his seeing a plasterer execute an elaborate ceiling of a tomb in India by working out the pattern with a lath on the wet plaster. So extraordinary did this skill appear to him that he watched the plasterer the whole day, and at night told his dragoman that he was the cleverest artist he ever saw. The dragoman maintained that he was a very stupid fellow, and said his father was a clever fellow, he could do five patterns, he had five sons, all of whom could do three or four patterns, but this man was so stupid he could never learn but two; the artist was less surprised when he found the man had been all his life at two patterns only.

* See Owen Jones's "Alhambra," vol. ii., plates 9 and 10.

In the present day most of our internal plaster work of any pretention is done in canvas plaster. A thin coat of fine plaster of Paris is brushed into the mould, very thin open canvas in strips is pressed into this, and brushed over with coarse stuff, the whole is then stiffened with slips of wood, attached to the backing with canvas and plaster, it is then dried in a hot room, and screwed up in in its place, and can be painted on at once; its greatest merit is its lightness. The day after the late Lord Derby dined at one of the City Companies' Halls a rose out of the coffered ceiling fell down, and smashed the solid mahogany dining-table. The defects of canvas plaster are its want of flatness in the larger panels, and of straightness in the cornices.

Bronze, though it becomes a blackish green, has this advantage for the decoration of buildings, that it can be reproduced as often as you please from the modelled clay of the statuary. You may, therefore, get through its means first-rate work at a low cost, if the repetition is great, and its use may be called benevolent as well, for it does not condemn skilful men to the brainless work of constantly reproducing the same thing.

It is needless to speak of wrought iron, which can be made into any form you like, and of any size and thickness, from the stem of an anchor to a leaf, and chased or engraved, polished or lacquered, tinned or gilt. I am happy to say that wrought ironwork is receiving great attention again both from architects, painters, and ironworkers, and can be made nearly as well as it ever could. I think cast iron has been needlessly depreciated, and needlessly neglected, in this truly iron age! You cannot get the fineness of bronze, and you cannot chase it, but you can get really beautiful work done in it, and the wit of man can never be better employed than in using good materials at hand in the proper way, *i.e.*, by only asking them to do what they can do readily and properly. As far as I know, the only real drawback to cast iron in its liability to rust. If Mr. Barff's process can be applied cheaply, and will resist the attacks of the atmosphere for a long time, all we have to put up with is blackness, and if the parts of a front we must have blank were filled in with glass slabs, you need have very little more black than you want. Considering how much we want light, and how dear ground is in London, it does

seem very odd that cast iron is not more used.

Cast iron is a difficult material to use, I mean it wants to be calculated for its strength, it requires much thought to ornament, and everything, even to a bolt hole, has to be settled beforehand, and, except there is much repetition, it is costly. Its neglect is greatly owing to this, that no one will pay for the extra skill, time, and trouble required of the architect, so this admirable material is almost ignored. The iron statue of Epaminondas is spoken of by Pausanias, and some scholars think it was of cast iron; at any rate Pausanius tells us "The Samian Theodorus was the first discoverer of fusing and making statues in iron;" so Mr. Ruskin's diatribe against cast-iron statues seems to be uncalled for.

If people were as good judges of art and skill as they are of port wine, they would not think it extraordinary that it was paid for in the same ratio; the amateur of port who pays 3 guineas a bottle for it, neither envies him who drinks it at 1s. 9d. a bottle nor thinks his wine merchant a swindler for charging him the higher price. As regards marble, I cannot quite agree with M. Charles Garnier, "that even when it has lost its polish it still looks like a shabby gentleman, and is not to be mistaken for a vulgar fellow in his Sunday clothes." Except in rainy weather, when the marble is temporarily polished by the wet, its unpolished surface, in my opinion, cannot be regarded as worth the outlay, and I say this with hesitation and regret, for the exquisite harmonies produced by the decayed marble of St. Mark's was a thing to be remembered; still as an architect, I cannot reconcile myself to using a precious material merely to give a flavour when I know that, in giving it, it is going to decay; I might, perhaps, if I were a painter. But for the inside of a building marble is the richest material you have for the production of lovely colour—music without words—painted as it is by Nature's hand, with every tint and tone of delicacy and subtleness, and enlivened too by the wildest caprices of beauty.

The bar to its use in England is the damp, for when the air is full of vapour the marble condenses the moisture, which stands on it in drops or trickles down it. But as most houses and buildings are now warmed, this need not stand for much, and if we panel our rooms below with wood, there is no reason why the upper part should not be of marble. Few of us know the wealth of England in marbles, but so little is it used that it is hardly worth the quarry owners' while to exhibit adequate specimens of their treasures. We all know the commoner sorts of Devonshire, and some of the beautiful serpentines of Cornwall; are we equally well acquainted with the lovely Irish green, superb black, and its red; with the beautiful green of Anglesea, and the Scotch and Irish porphyries? Marbles are of every hue except blue, for blue Belge is black and white, and blue Napoleon, or Imperial, is but bluish-grey; and brown is scarce, though we have rosewood marble and Californian spar. Marbles are found in most countries of the world, and there are such vast varieties in Europe that they can hardly be catalogued.

During my lifetime many of the old abandoned quarries of the Romans have been re-discovered, so that Giallo antico, rosso antico, and other antique marbles, have lost their preciousness in value and their epithet. The Romans had a much more pronounced taste for colour than the Greeks seem to have had, and were enthusiastic admirers of marble. There are still miles of buried marble on the banks of the Tiber, awaiting a revival of this splendid taste. It is only quite lately that any appreciation of what polished marble can do for us has revived, and there are still but few examples of the use of fine marbles in large masses. Still fine examples may be seen in the staircases at Dorchester-house and Goldsmiths'-hall, and in halls at the Holborn Restaurant and the National Gallery. The late Mr. Burges had the upper part of his dining-room lined with red Devonshire. In Italy the former passion for marble may be seen in buildings of Roman, Byzantine, Romanesque, Gothic, and Renaissance times, *i.e.*, at Rome, Ravenna, Venice—especially at St. Mark's—at some of the churches at Genoa, at Pisa, and in the mausoleum of the Medici at Florence. Great taste in colour is requisite for the proper arrangement of coloured marbles; at present no one cares to exercise this taste as a profession, as there is so little effective demand, and in spite of the low tone of marble generally, it is much easier to make a vulgar or discordant arrangement than a strikingly good or harmonious one. The fashion of using white marble chimney-pieces, white marble bas-reliefs, white marble statues and busts in decorated apartments, is absolutely fatal to low-toned schemes of colour decoration, and as a rule all gorgeous schemes of colour are low-toned, and white must then be used most sparingly as a jewel. White can only be

sparingly ornamented with morsels of full colour, or very high-toned decoration must be used in conjunction with it, as this alone can sustain masses of white.

Sculptors, unhappily, have a tradition that deep red is a good background, but as green is its complementary, red makes the statues or bas-reliefs look even colder than the natural colour of white marble.

Considering the wealth of this country, which mainly goes in useless feasting, useless men and maid servants, useless carriages and horses, and hideous as well as useless clothes, I do not think those who will not use marble from poorness of spirit are included in the beatitudes.

As I am now on marbles, I may as well include mosaic pavements. These must be greatly restricted in so cold and damp a place as England. Few of us love to walk on a marble floor without shoes or stockings, as all would do in a warm or hot climate, but it can be used for the pavement of Protestant cathedrals, for hall floors, for the centre aisles of churches, for conservatories, porches, terraces, and the like; and when we can afford it, porphyry is by far the best material for the patterns, as it only polishes by the friction of dusty boots, unlike marble, which roughens, and unpolished marble is not more attractive than stone. Plain geometrical and flat floral patterns are the best, in marble or pottery floor mosaic, for the smallness of the pieces rather helps the scale of the room or building, and does not ruin it like marble squares. The effect of a geometrical pattern in porphyry on a white marble ground, called, after Severus Alexander, *Opus Alexandrinum*, looks very splendid in the Basilicas at Rome. Though, as a rule, man's work, when not too bad, must be always most pleasing to mankind, we want occasional variety, and some of the pavements composed of mere lumps of finely coloured marbles like gigantic breccia is a pleasing contrast and change from too much of man's handiwork, and I cannot conceive any pavement of more imperial magnificence than some of those Roman floors said to have been made of lumps of lapis lazuli.

The objection to pottery as mosaic in floors is its softness, so that it soon wears away under much traffic. Figure pictures, for a floor to be walked on, are a mistake, though they may be used as a centre-piece to be looked at from above, and be surrounded by plants or flowers; but nothing can be more appropriate for internal wall decoration than figure subjects, or floral ornament in marble or tile mosaic; in either case it is permanent, and can be easily cleaned, and that in marble, at least, must be low in tone, for it can have but two colours of complete purity, white and black.

England has got rich these last sixty years by flooding the world with rubbish, so nothing can be more patriotic than having a piece of the best workmanship you can obtain put in your house, and by that I mean attached to the freehold, if it be your own, and let this piece be adorned by the hand of an artist, for his workmanship is transcendental, and, if possible, let it pourtray a noble example, or evoke a noble reminiscence, and be of such materials that it cannot well be sold or destroyed for the value of the material. A modelled terra-cotta frieze or panel is valueless except for the art, and has the very touch of the artist's tool upon it, and if you can get a painter to make it also beautiful with colour, or have it enamelled in colour from a painter's cartoon, you will have two of the highest forms of beauty to enjoy while you live, and you will leave the best of all possible heir looms to your children, and to posterity, except a name or wisdom, courage, and integrity.

Although it is very mortifying that your landlord should steal a beautiful thing, and one probably costly as well, perhaps even destroy it, we should draw on our philosophy, and feel that it is worse still to lose the embellishment and ennobling of life; so that, if our leasehold is not very short, I think we may resign ourselves to casting our bread upon the waters.

Miscellaneous.

PARIS EXHIBITION.

The buildings for the Exhibition have made great progress during the last five or six weeks. The large Machinery-hall at the south end of the Champ de Mars is now considerably more than half finished, and will probably be completed in another six weeks or two months. The galleries in which the principal British exhibits will be placed are now practically completed, except the flooring. The principal parts of these galleries have long been standing, but they have now been walled in, and could be made ready for occupation at any time. It is proposed to use this portion of the building for a dinner which is to be given on the 14th instant, in connection with the Exhibition, to about 4,000 persons.

Considerable progress has been made with the

Fine Art Galleries; but, as they were not commenced until recently, they are not nearly so far advanced as the other parts of the building. The same remark applies to the other parts of the building for the classes included under the term "Liberal Arts," on the other side of the grounds. In this last-named building it is proposed to place a retrospective collection illustrating the progress of the arts and industries from the very earliest periods, and application has been made to the London committee to assist in this department. On the Esplanade des Invalides, the construction of the various small buildings with which it is to be filled has been commenced. This work has been deferred as late as possible, in order not to deprive the regiments quartered in that part of Paris of their remaining drill ground for a longer period than was absolutely necessary.

The roofs and ironwork of the long range of galleries extending along the Quai d'Orsay, and connecting the Champs de Mars with the Esplanade des Invalides are now nearly all up. As the galleries in which will be placed the British Agricultural exhibits are at the extreme end of this range, nearest to Paris, while the construction was commenced at the other end, these are not yet up. The side walls of these buildings have also been constructed for a considerable portion of their length, so that this part also of the Exhibition will be finished at no very distant date.

The tower which will form so conspicuous a feature of the Exhibition has now reached about half its height. The two lower storeys are now completed. The first one, forming the base, extends over a considerable area, and resembles in appearance a huge, four-legged table or stand. Its height is about 250 feet, or a quarter of the whole. On the top of this is placed the second storey, of about 200 feet high; and from this second storey springs the tapering column of between 500 and 600 feet in height. The point now reached is the summit of the second storey. Access is obtained by means of an iron staircase built into the framing of the tower; but the guides in which the lifts will work are already in place, and when the tower is finished, the various stages will of course be reached by means of these lifts. The foundations are sunk a great depth into the ground, which at this place—close to the bank of the Seine—is less suited for bearing a weight such as a tower than the limestone rock which underlies the greater part of Paris. Great precautions have been taken to render the tower safe from lightning. It forms, of course, a conductor in itself, but, to ensure proper connection with the earth, at each corner a large tube has been sunk a considerable distance into the soil, and these tubes it is proposed to keep full of water. Good electrical connection is made between the tubes and the framework of the tower itself. It remains to be seen whether a building of this enormous height will carry off electricity safely in consequence of its excellent conducting powers, or whether it might not suffer from a shock of more than usual violence. The site is certainly but ill-chosen to enable the tower to make the most of its height, since it is on some of the lowest ground in Paris, and in spite of the enormous height of the building itself, at the present time, its top is now only on a level with the summit of the towers of the Trocadero Palace, a building which, though much inferior in size, stands on the high ground on the other side of the Seine.

The French executive report favourably as to the exhibits which they expect to receive from foreign countries. Considerable sums have been voted, amongst others, by various of the South American States, as well as by the United States, and by Belgium. The Spanish Government, though not officially represented, have voted a large sum towards the Exhibition, and it is said that the unofficial committees in various of the European States are most of them successful in securing a represention of their several countries.

As regards England, the space in the Industrial Courts is not sufficiently large to meet the demands which have been made upon it, and which are still coming in; and very shortly it will be impossible to entertain any new applications whatever. The space in the Machinery-hall also is nearly filled. The report is less satisfactory as regards the Agricultural Galleries, as up to the present the agricultural implement makers have rather hung back. The question of allotment in all sections of the Exhibition is now receiving careful consideration. Negociations are being made with the French executive for the organisation of an Indian Court, a number of applications for the exhibition of Indian goods having been received by the London committee. All the railway plant is to be shown in a separate part of the Exhibition, the French executive having determined to retain in this section alone of the Exhibition their original idea of classifying all the exhibits according to their character instead of by nationalities. It seems probable that, after the French themselves, the most important contributions in this section will be those from England.

PROJECTED RAILWAYS IN ASIA MINOR.

A new railway is projected from Constantinople to Bagdad, to start from Ismid, the present terminus of a short line of railroad connecting that town with Scutari, the Asiatic suburb of Constantinople. Its length is about 1,400 miles, and the estimated cost £15,500,000. Throughout its length it will traverse a country well populated, abounding in mineral resources, and producing great quantities of grain. Consul Jewett, of Sivas, says that the great advantages to the country, commercially and as a civilising influence, of such a road are too obvious to need mention. It is sufficient to say that it would create a new Asia Minor, open to the trade of the world a vast territory now closed, totally change the character of the country and the people, and practically advance Turkey in Asia from the 16th to the 19th century; moreover, the com-

mercial world at large has a special interest in this project, as it will, if carried out, shorten the distance between Europe and India by nine or ten days, and give a route to the East independent of the Suez Canal. The following are the principal points along the proposed route. Angora is a city of about 20,000 population, and is the centre of the mohair trade. The province of which Angora is the capital is rich in minerals of various kinds, especially copper and argentiferous lead. At Ak Dagh there is iron ore; at Mohallitch, copper and fullers' earth; at Likili, rock salt. The exports are mohair, sheep's wool, opium, yellow berries, gums, silk cocoons, rugs, and carpets. Fifty miles beyond Angora the proposed route crosses the Denek Mountains, where there are silver mines. Youzgat, the next important point, is a walled city surrounded by high hills. It has a population of 10,000 to 15,000. Kaisarieh—a branch line from Youzgat to the important city of Kaisarieh would probably be built. The distance is about 100 miles. Kaisarieh has a population of 60,000, and is a city of great wealth. Its principal trade is in hides, yellow berries, wool, and gum tragacanth. A line extending south through the Anti-Taurus Mountains, *viâ* the Cilician Gates, 150 miles, would connect the proposed main line with the railroad between Mersine and Adena, and give an outlet on the sea coast. The next important point on the line is Sivas, a city of 40,000 inhabitants. The trade of this city is entirely in the hands of the Armenians—it consists of hides, grain, rugs, wool, carpets, silver wire, vegetable dyes, &c. East and north-east of Sivas is an extensive mineral district, the centre of which is Kara Hizzar. This region abounds in argentiferous lead, coal, asbestos, and marble. Continuing south-east from Sivas the route passes Arabkir, a thriving town of 29,000 inhabitants. The people are principally engaged in the manufacture of coarse cotton cloth from English yarn on hand looms. At Deverige there are extensive iron deposits, and Keban Medan, near the Euphrates river, has silver and lead mines which have been worked intermittently for centuries. At Kharpoot the projected line crosses the Euphrates. The city occupies a conical eminence at the termination of a range of hills. The population of the city proper is about 12,000. Diarbekir is the next large city. It was formerly of great commercial importance, doing a large trade with India by way of Bagdad, and with Europe by way of Aleppo. It had an extensive silk industry, which has declined of late years, but the trade in silk cocoons is still considerable. The navigation of the Tigris begins here. Goods are floated down to Bagdad on rafts made of inflated skins. Following the valley of the Tigris, the line reaches Mosool, a city of considerable size. The neighbouring districts are possessed by wild tribes of Arabs, Koords, and Turkomans. From Mosool to Bagdad the Tigris is a broad stream, being enlarged by tributary waters of the Tjab, and other drainings from the mountains of Koordistan. On the eastern side of the Tigris, in the neighbourhood of Kerkook, are numerous petroleum and naphtha springs. The most abundant supply is obtained from the hills around, but a great deal is collected on the surface of the water in the ditches and stagnant pools. Some years ago this petroleum was largely used in Bagdad and Bussorah, but as the natives do not understand how to refine it properly, it has of late years been superseded by Russian and American oil. Consul Jewett says that if proper scientific methods were used in refining it, it is probable that the oil from this region might become of great commercial importance, as it is inexhaustible in quantity, and even without a railroad transportation is easy by way of the Tigris and Persian Gulf to Bagdad, Bussorah, India, and beyond. There is, it is said, no limit to the supply which might be procured from the hills about Kerkook and Arbela. These hills have been yielding bitumen and petroleum since the time of Alexander the Great, in whose honour Arbela was illuminated after his great victory over the Persians. The petroleum springs from almost every hollow in the hills. As it rises from the earth it is of a brownish colour with a greenish tinge. It quickly becomes opaque and hard, in which state it is easily broken, with a shining resinous fracture. The following is a description of the principal spring —a funnel-shaped hollow, ten or twelve yards in diameter. The hollow is filled with a dark blackish-brown substance, from the centre of which salt water bubbles up, and escapes to some salt ponds where, evaporating, its saline matter is left behind. The pit is very deep in the centre, but its shallowness at the edges permits the people to stand in it up to their knees, while they roll up the tenacious substance into masses, which are carried away and placed to dry in the heat of the sun. When hardened it is used chiefly for fuel for the burning of limestone. The flames give a strong light and heat, and it leaves a small earthy residue after it is burned. Notwithstanding the quantity that is constantly drawn off, the petroleum always continues at the same level, and the Hittites say the supply in the pit is inexhaustible. Bagdad, the terminus of the proposed line, is a city of some 80,000 people, the centre of a vast outlying district and population, and the commercial emporium of Turkish Arabia. One of the chief exports is wool. The trade has in late years declined owing to the competition with Australian wool. Bagdad wool is principally used in French looms for carpet manufacture. The quality varies with the breed of the sheep and the pastures in which they graze. The most esteemed is raised by the Beni-Lam and Montifik Arab tribes, and is of a fine silky fibre and elastic quality. The quantity of grain produced about Bagdad and along the Persian Gulf is immense, and at times the supply is so abundant, and the means of transportation are so inadequate, that wheat is used for fuel on the coast of the Persian Gulf. Gall nuts and gum tragacanth are

gathered on the surrounding hills. Mulberry trees grow in abundance, and experiments in silk manufacture are reported to have resulted favourably. Rice of very good quality is produced, and of late years the cultivation of sugar-cane has been introduced from Egypt. Should the railroad be built, it is said that Bagdad, as the *entrepôt* for the trade between the East and the West, is sure to attain a commercial importance hardly second to any city in the East. Consul Jewett says, in conclusion, that with the advent of the railroad, with the new towns and cities that will spring up, the new resources and industries developed, and especially with the new ideas and wants which civilisation creates, there will be a new market, and a constantly increasing demand for almost everything which Europe and America manufactures.

Correspondence.

EXAMINATION IN MODERN LANGUAGES.

I was glad to see in our report (p. 902) that provision has been made for additional examinations in modern languages. The subjects proposed are Portuguese, Russian, Chinese, Danish, and Modern Greek.

Upon this I would remark that Portuguese, Russian, and Chinese are very valuable. Portuguese provides for our great interests in the growing Brazilian empire, in which so many Englishmen are concerned. Russian speaks for itself, and so does Chinese. Danish appears to be of very limited practical use for our commercial purposes, and so does Greek.

What should have been included are the Japanese and Turkish languages. Japanese has the advantage that it can now be readily studied in the Roman character, and for conversational purposes it can be easily learned by Englishmen. A great movement began last year for the extension of Roman characters among the Japanese themselves, instead of the most complicated native systems.

It is to be hoped the examinations will be directed to conversation, and not to grammar or classics. Mr. John Addison, M.P., has well exhibited in the *Times*, lately, the mischief and delusion of the ordinary scholastic methods of grammatical teaching and examination. For commercial purposes we require linguistic capacity, and Sir R. Burton has given excellent practical advice in this respect. A man who attains proficiency as a linguist does not begin with a grammar if he can help it, any more than a child, as Mr. Addison says, learns English from a grammar.

It is very desirable to know what the Examination Committee proposes with regard to Chinese. If the members have in view what the professors of Chinese teach, that is not what our merchants want. The mandarin character and grammar, even for conversation—as that distinguished scholar, Sir Thos. Wade has shown in his new manual—require profound study. On the other hand, in each port a language is spoken which differs materially from the classic language. These local languages have been, of late, reduced to Roman writing, and very useful books have been compiled for their acquirement, which is not difficult. Thus in the new school of languages at Berlin, of which, to our great shame, there is no parallel institution in London, there is a special teacher of the Amoy and other local Chinese languages.

HYDE CLARKE.

32, St. George's-square, S.W., July 6, 1888.

LOCKS AND SAFES.

I did not state in my paper who first used sandwich plates, *i.e.*, a thin plate of hard steel placed between two safe iron or steel plates, as, in my opinion, this form of construction is almost the worst possible. So strong has been my aversion to these sandwich plates, which I find are sometimes falsely called "compound steel," that I have always refused to recommend or to specify them. Respecting the **T**-frame, I stated that I could find no mention of it in the Patent Records, except my own of 1862, before 1865. Your correspondent, on what must be mere hearsay, informs your readers that this is the invention of their Mr. Noakes, whose patent is not dated until 1866.

SAMUEL CHATWOOD.

General Notes.

COAL IN THE UNITED STATES.—The production of coal in the United States in 1887 was 16,000,000 short tons in excess of that of 1886, the increased value at the mines being estimated at 26,418,241 dols. The total production was 123,965,255 short tons, and the value 173,530,996 dols. Of this 35,273,442 short tons were Pennsylvania anthracite; all other coals, including bituminous, brown coal, lignite, small lots of anthracite produced in Colorado and Arkansas, and 6,000 tons of graphitic coal mined in Rhode Island, amounting in the aggregate to 84,459,000 short tons, valued at 94,165,752 tons. This does not include the amounts used at the collieries, which varied from nothing to 8 per cent. of the total output of the mines. This was greatest at special Pennsylvania anthracite mines, and lowest at those bituminous mines where the coal bed lies nearly horizontal, and where no steam power or furnaces are used. The averages for the different States vary from $2\frac{1}{10}$ to $6\frac{1}{7}$ per cent., the minimum average being in the Pennsylvania bituminous, and the maximum average in the Pennsylvania anthracite region. These figures were obtained from the direct returns of the operators of individual coal mines, and from railroad agents and State officials, by the Division of Mining Statistics and Technology of the United States Geological Survey.—*Engineering.*

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FRIDAY, JULY 20, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

TESTS FOR PRIME MOTORS.

The tests for Prime Motors will take place in September, on the ground belonging to the Imperial Institute at South Kensington, which has been kindly lent for the purpose by the Committee of the Institute. The preliminary tests will commence on the 12th September, by which date all engines must be fixed and ready for work.

PRIZES FOR ART-WORKMEN.

The Council of the Society has received a grant from the Court of the Goldsmiths' Company of £50, to be awarded in prizes for the encouragement of workmen connected with the goldsmiths' and silversmiths' trades.

On the advice of the Committee of the Section of Applied Art, the Council therefore offer the following prizes for art-workmen, in addition to those already announced in the *Journal*:—

A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First Prize £20; Second Prize £5.

A pendant or brooch, or locket of gold without gems. First Prize £20; Second Prize, £5.

The articles for competition must be sent in to the Society of Arts House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered are the same as those for the prizes for pottery, stone carving, and wrought-iron work, which have been previously announced in the *Journal*.*

* See *Journal*, June 15.

Proceedings of the Society.

CANTOR LECTURES.

DECORATION.

By Professor G. Aitchison, A.R.A.

Lecture III.—Delivered May 14th, 1888.

Amongst the ancient Greeks and the Northern Italians of Renaissance days, beauty was adored. Every man who practised a craft was as sure of fame if he followed what we now call a humble one as if he followed a noble one, provided that the articles he made could be endowed with beauty, and that he possessed a certain high degree of excellence. A carpenter, an armourer, a potter, a goldsmith, a lapidary, or a bronzist, was as certain to be famous as a sculptor, a statuary, a painter, or an architect. We naturally know less about the ancient Greeks than about the Italians, though, from Socrates being a sculptor, we hear something of the crafts, and we know that Phidias was not only a sculptor and statuary (and I use the word statuary in its proper sense as a worker in bronze), but worked also in ivory and gold. The great Italian artists were almost invariably craftsmen as well, in fact had begun as craftsmen, and had learned during their apprenticeship precision in the use of tools, and in workmanship, as well as precision in drawing and modelling. As a rule, every youth who wanted to be a painter, sculptor, or architect, was apprenticed to a goldsmith. Brunelleschi, Michael Angelo, and Benvenuto Cellini were all brought up as goldsmiths; one became an architect, one a sculptor and painter, and one a statuary and die sinker; Ghirlandaio got his name from the golden wreaths he made, and Francia, as you may see in the National Gallery, signs his pictures as a goldsmith, while he signed his goldsmith's work as a painter, and, like the French artists of the present day, these artist-craftsmen were often excellent shots and swordsmen as well. One of the absurd things in the present day is the looking down on craftsmanship; a real craftsman can always do something well. If he can invest the article he works at with the highest form of beauty, he is just as much an artist as he who paints a picture, models a statue, or designs a building.

The best definition of fine art I ever found is in Mr. Ruskin's lecture (2nd Oxford lecture, 1870), "Every art being properly called 'fine' which demands the exercise of the full faculties of heart and intellect."

A finely designed and finely executed gem is just as capable of raising the loftier emotions as a bronze statue or a marble bas-relief; and, speaking personally, I should be inclined to place the glazier's art next to the divine arts of poetry and eloquence, for like Timotheus' song, it has "raised a mortal to the skies."

To those who have the passion for colour that some have for music, beautiful coloured glass offers the same feast to the eye as exquisite music does to the ear, and from the fact of glass being transparent it does not appear like a tangible object, but, when lit by the sun, it looks like gems melted into light that bring all heaven before our eyes, and surrounding objects are suffused with its divine harmonies. I think I may say it is the only visual art in which man can emulate, if not excel, Nature. In pure loveliness of many colours it exceeds in beauty the rainbow, or the sunset, and appears as if some divine affluence had come from heaven to entrance us. It defies the painter's brush and the poet's pen, though we cannot help feeling that Shelley was the poet most highly sensitive to the rapture produced by the glory of coloured light. In his description of fire he shows an appreciation of the beauty we meet with in stained glass, and did not merely use it as a foil to music:—

> "Men scarcely know how beautiful fire is,
> Each flame of it is as a precious stone
> Dissolved in ever-moving light, and this
> Belongs to each and all who gaze upon."
> ("The Witch of Atles," stanza 27.)

Milton's "Storied windows richly dight" only give a flavour to his enjoyment of music:—

> "There let the pealing organ blow
> To the full-voiced quire below
> In service high and anthems clear,
> As may with sweetness through mine ear,
> Dissolve me into ecstasies,
> And bring all Heaven before mine eyes."

The Poet Laureate uses it in the same way:—

> "And thunder-music, rolling, shake
> The prophets blazon'd on the panes."

This rapture is only produced by a few specimens of stained glass, mostly of the 11th or 12th centuries; though perhaps some of the windows of the cathedral at Florence are almost as lovely as those of Chartres, or the aisle windows of the choir at Canterbury. Next to them are some of the Saracen windows; these seem to have been copied in plaster from the pierced marble ones of Sta Sophia, and from the fact of the substance of the window slabs being thick, and the edges of the openings being splayed, you can infinitely vary the effect by moving into different positions. Some most love the suffused light on the splays, but to me the effect is most lovely when I get the bulk of this reflected colour with gleams of the glass through which the sun streams, making them look like different coloured stars in a halo of glory. Next to these full-toned windows in loveliness are those of fine old grisaille glass, especially when seen towards sunset, and when exposure has converted each quarry of white glass into mother-of-pearl.

The Cathedral of Poitiers has windows of grisaille, that I once saw just as the light was fading, and they made me ask myself if anything could be lovelier. After grisaille is some of that glazing which is only translucent, and has been done with onyx or marble, where one lovely pale tint fades into another, and then swells and fades again, "untwisting all the chains that tie the hidden soul of harmony." At San Miniato, Florence, the windows of the choir are glazed with slabs of pavonazzetto, and look like glorified tortoise-shell. Besides the genius and labour of man, Nature has lent her aid to produce these unsurpassable effects in old glass. She has, by roughening and eating into the surface of the glass, turned white into opal, and by partly overspreading them with dirt and lichen she has converted flat tints into cut jewels. Directly we get stained glass windows whose forms and colours we can calmly criticise and admire, they fall into the ordinary category of beautiful human works, and to me are far lower in the scale than those that, when illumined by the sun, seem but a shapeless mass of coloured loveliness, which throw us into rapturous adoration, and seem as if they could not have been done by man, but that angels must have been sent from heaven to present us with them, so that we might be at once delighted and thankful.

When we attempt to copy the fine early stained glass, consisting of subjects to a small scale, we barely rise to respectable mediocrity. Supposing we have the old glass to copy from, the failure can only arise from one or more of these causes—want of skill, inferiority of material, or the effects of age. The want of skill I cannot speak to, though it is to be supposed. The old glass was mostly done by monks, who devoted their time and genius in this

direction as the best service they could render God, and who, consequently, considered that no time, no labour, and no care was too great to make their offering worthy. Such a sentiment we cannot find now, and can barely understand. Perhaps I can throw some light on it by a story from "Greater Britain." It is acknowledged in America that no fruit growers can compare with the Shakers in the excellence of their fruit. The author asked one of them how they managed it; he said, "If you love the trees, you study them, and you find out what they like and dislike; some like shade, some like sunshine, some like beautiful flowers, some like perfumes. If you make them happy, they give better fruit."

Next, as to material. Scandalous as it is to confess, we are grossly inferior in that, and knowingly so. Any manufacturer of coloured glass would tell you the fact in a moment; he would simply say, "it is not worth my while; make it worth my while and I will do it." And he might even add that, with all our chemical knowledge, and all our skill and appliances, he would undertake to make better glass than had ever been made before. I do not say he could, but he would thoroughly believe he could. Love and patient skill can achieve wonders. The earlier Indian gems were pierced only for a hair, and the instrument seems to have been a twig and some emery. And some of the most heavenly blues of early glass have never been equalled. Theophilus, a monk of the 11th century, tells us that this blue glass was only to be got "in the ancient edifices of the pagans. Some small vases are also found . . which the French . . . collect, and some melt the sapphire in their furnaces, adding to it a little clear and white glass, and make costly plates of sapphire, and very useful in windows." *

The Romans certainly had not our chemical knowledge nor our appliances, but they may have had greater pride in their skill, and greater skill.

The application of science tends to diminish skill, and the object of the manufacturer is to extinguish it. There is a trade proverb, that "No man can make his fortune who has to employ skilled labour." There are many other forms of coloured glass than the full-coloured; that in which the whole tone is light, and the variations in tone and tint are the slightest, is the most charming in effect, like those Italian low reliefs of the Quattrocentisti, where the highest part of the relief is not the eighth of an inch. There are, too, a thousand ways in which different sorts of coloured glass can be introduced to give beauty to windows of every description, and in every variety of building.

Glass, too, offers us a field for recording reminiscences of fine form as well as of fine colour; of form particularly when the window is placed where no direct sunlight comes on to it. Two or three things must always be considered when stained glass is used. You do not want highly coloured painted decoration, nor that which is elaborately full of work, where deep-toned stained glass is used, this conjunction not only leaves no rest for the eye, but the colour of the dead painting is spoiled by the coloured rays. Nothing goes so well with the most magnificent full-toned stained glass as the greys of old stonework; next, you can no more leave a white window where the bulk are of fully coloured glass than you can put up a white chimney-piece in a room decorated in a full tone; and, again, whatever be the tone of the chamber, if the wall decoration be full and elaborate you only want enough work on the glass to suggest intention. You must not suggest want of completion, but merely the studied absence of ornament to give effect to the elaborated parts. Greek work is absolutely perfect in this respect; it says to you, "My author did not leave me plain for want of industry or skill, but because he considered by doing so he showed that highest skill, of knowing when and where to stop." In the best Saracen work a similar effect is got—though, in my opinion, a lower one—by gradation. All is ornamented, but in the general effect the lighter ornament appears as mere texture, if not as a plain surface. The Saracen does not take so lofty an intellectual position as the Greek, for he either mistrusts his own judgment or yours; by going close enough you can see he has worked, while the Greek says, "Raise yourself to my standard and you will then understand the value of this elaborate plainness."

There is one very comic belief that is applicable to stained glass, as it is to all the arts that combine the useful and the fine; persons who cannot draw on paper think they can on glass, or on pottery, or on silk, and persons who are more or less colour-blind think the same about colour. If foremen of house-painters are not chosen for this defect their employers certainly look on it as a most pardonable weakness. I may add, too, that the art of drawing, modelling, or designing form, by no

* Theophilus, lib. ii., cap. 12.

means confers the gift of colour on its possessor; many have this charming faculty of harmonising colour who cannot draw. In fact, the highest excellence in either, if not antagonistic to the other, is exclusive by predominance. The Tuscans were specially formists, while the Venetians were colourists. We should not go to Michael Angelo or Raphael for colour, nor to Titian or Tintoret for form, though both schools are passable in the opposite gift. If a painter is not a colourist he should change his occupation, for if the colour of his pictures is vile we do not look at them, while if the colour is superb we may at last study the form.

I think we may claim a new departure in stained glass, for some of Mr. Burne Jones's windows in Oxford Cathedral are both new in treatment and beautiful as well. In one of Mr. Ruskin's lectures he confirms the theories I ventured to uphold in my first lecture. In speaking of the windows of Chartres, he says:—

"We profess that this is to honour the Deity, or in other words, that it is pleasing to Him that we should delight our eyes with blue and golden colours. . . . . . I do not think it can be doubted that it *is* pleasing to Him when we do this, for He has Himself prepared for us, nearly every morning and evening, windows painted with divine art, in blue, and gold, and vermilion; windows lighted from within by the lustre of that Heaven which we may assume, at least with more certainty than any consecrated ground, to be one of His dwelling-places."—(Oxford Lec., p. 81).

Enamel.

As the material of this is glass, I have joined it with stained glass. In the present day it does not greatly flourish; its most common form now-a-days is like painting on china, and is called painters' enamel. There is a tradition that true enamelling originated in Gaul, though the use of inlaying the precious metals with coloured stones, coloured mastics, and coloured pottery was known to the Egyptians, and was in its effect very similar; just as the Chinese ornaments inlaid with the blue feathers of the jay's wing cannot at a little distance be distinguished from enamel. The three enamels known besides the painters' are called partitioned (*cloisonné*), dug out (*champlevé* or *in taillé d'epargne*), and translucent.

The old *cloisonné* had its centre at Constantinople, and the ground and the partitions were of gold, into these coloured glass was filled in powder, or mixed with a little gum water into paste, fused, and eventually rubbed down smooth, and polished. There was a great demand for this art in adorning personal ornaments, book covers, church plate, and altar fronts, but from the costliness of the material it was very dear. At Limoges they manufactured a cheap imitation, particularly for the larger objects; the spaces for the enamel were cut out of solid brass, copper, or bronze, the enamel was treated as before, and the metal gilt. The translucent required the highest skill. The ground was mostly of burnished silver, on which the figures were engraved, and translucent enamel filled in of the requisite colours, or the whole plate was covered with enamel. To get the enamels of different colours to fuse at the same time, or in succession, as there were no divisions to retain the colours, required knowledge, experience, patience, and exquisite skill, for if the heat required to fuse one colour was greater than to fuse another they were apt to mingle. In the 16th century in France, the taste for dug-out enamel almost ceased, and the glass painters of Limoges used copper plates, sometimes silvered, sometimes with tinsel fused on, and covered mainly with translucent enamel, for the plate and ornaments of sideboards, personal jewellery, &c.; this was gradually superseded by enamels in white, or light grey, on a black or dark-blue ground; the early ones were touched up with gold lines and hatching, until this was superseded by mere china painting; the only difference being that, in the case of enamels, the ground was copper, thickly enamelled in white, on which the painting was done.

The earlier Limoges enamels of the second period are very effective, and the larger specimens have been used as ornamental panels, and to adorn furniture, &c. I am happy to say that enamelling for decorative purposes is again being introduced. (Some specimens exhibited.)

The arts of the carpenter and the potter are two of the oldest in the world; as soon as mankind wanted boiled food, they had to invent something to boil it in, though probably the process was inverted, and when they got something that would stand heat, and hold water, they took to boiling their food. Shells were doubtless used as the first drinking cups by those living by the sea-board, and calabashes by those inland, and we still find gourd-shaped bottles, with the double bulb, in the pottery of the East; the hafts of weapons and tools were probably the

first specimens of the carpenters' art; then came the carved club and the javelin, subsequently the canoe, so aptly called by the Americans a "dug out," and the paddle. Framed huts of wood must have been a late invention, and doors and shutters a still later one.

Nature always makes her works fitted for their end, and when she likes, and she mostly does like, perfectly beautiful as well. So long as mankind were in constant contact with Nature's works they tried to imitate her methods, but at last they discovered that this involved two processes. So that when they ceased to care for beauty they grudged the necessary labour to attain it. It is a million to one against a thing made by man, with no other end in view but utility, turning out beautiful.

Though ornamenting wood with incised or carved patterns was probably an early invention, it was no easy thing to mould it, hence the belief that the original Greek eaves of wood were first covered with ornamental terra-cotta, which was subsequently copied in stone. In speaking of woodwork it is necessary to describe the material, and the way of putting it together. The thickest tree trunk is rarely wide enough to make a door of the centre plank, and even if it were, it is apt to crack and twist as it gets dry; to get over these difficulties boards enough were laid side by side, and fastened together by planks on the back at right angles, but this shows a series of parallel lines, either vertical or horizontal; the next step was to frame a thick skeleton, and fill in the open spaces with thinner pieces called panels. All that sort of woodwork that is called framed joinery practically comes to this, though some races have preferred putting all but the outside framework at acute angles; the best known specimens of this methods are to be found in Saracen and Japanese work. The abrupt step from the plane of the frame to that of the panel was softened and beautified by moulding, and, except by different treatment of the width, thickness, and curvature of the mouldings, there is no way of bringing plain framed woodwork into the realm of art, but by proportioning the panels and framework harmonically; we can then engrave or incise the whole, or parts, or we can carve them into patterns or into figures. Wood has a small range of colours, white, yellow, red, brown, purple, and black, and a great variety of tones and tints in these colours, and we can still more vary the tints by oils, resins, and gums. Dragon's blood is much used for staining mahogany, rose, and other woods that are reddish by nature, or are wanted to be so, and is now known to be the resin from a palm, and was one of the Greek cinnabars, the other being vermillion; but Sir John Maundevile, in his "Travels in the East" (1322-56), gives an account of how they hnnted the dragon for his blood. Few woods stain well except in small pieces, and when stained are mostly used for inlays. Woods are sometimes variegated, usually marked by stripes, veins, curls, or dapples. As the mind of man is greedy of novelty, we admire that to which we are unaccustomed, and often imitate a choice wood by painting a common one. In France they sometimes grain oak to imitate deal, while we grain deal to imitate oak.

Wood may be inlaid with other woods, with bone, ivory, tortoise-shell, mother-of-pearl, and other shells, with metals, with marbles, with precious stones, with glass, pottery, china, or enamel, either plain or in patterns. Living as most of us do in hired houses, we hardly think of anything but painted deal, the painting being renewed every few years, according to the caprices of fashion. Modern inlaid woodwork most of us have never seen; what we take for it is marquetry—two veneers of different colours cut into the pattern wanted, and one fitted into the other, and the whole glued on to a backing. Inlaying is sinking out the solid wood and letting in pieces of other coloured materials, and requires much greater care and skill than marquetry. There are said to be only five men in England who are first-rate at marquetry, and that most of them are foreigners. The main merit of real inlay is this—that at the worst the inlay can but come out, while veneer, if it gets damp, or if the glue gets too dry, comes off bodily. Very few people appreciate the value of hard wood, which has the incidental merit of not bruising so easily as soft; but its main merit is preserving the decorative colour originally designed, and that it can be inlaid, or if carved, is not spoiled by successive painting. Oak is mostly our highest ambition; the mediævals and the people of the last century were quite right to plaster and paint, or to gild it, for new oak is one of the vilest colours—a sort of cross between cold veal and a top-boot. If not French polished, it may get a decent colour in the days of your great-grandchildren, though when new it does not make a bad background for inlays of ebony, other coloured woods, and

ivory. Spanish mahogany also looks well when it is about a century old, and is then a blackish purple. For dignity nothing is so serviceable as ebony, or wood stained black. Ebony varying from black, through brown to yellow, or through grey to black, has the inestimable advantage of variety, which dyed wood mostly wants. In this respect it is like real black marble, that is rarely without variations to grey or brown, and more often than not has white flecks or veins in it, so that you do not mistake it for enamelled iron or slate. [Specimens of marquetry shown.] The parquetry of floors may be equally well inlaid in patterns, only it wants to be done on a larger scale.

For the necessary woodwork of a building, exclusive of furniture, little turning is required, except for balusters. Turning is a cheap means of contrasting two or three simple forms, the square, octagon, &c., with the round, and getting harmonic proportions in the round; for the architect has to follow the example in the Eton Latin Grammar, "Mutat quadrata rotundis"—a great part of his art is in changing shapes from square to round. There is another method of enriching woodwork that I have omitted, and I hardly know where it originated or who carried it on—probably the Milanese; but you find abundant specimens at Venice, sometimes in doors, but oftener in picture and mirror frames, and in cabinets. The mouldings are mostly original, bold and striking, containing all the necessary variety of width, curvature, and projection; the mouldings are occasionally, and the flat surfaces are always, enriched by slight variations of surface that may almost be called textures, such as basket-work, minute beads (in the carpenter's sense) of various altitudes, often forming a meander; sometimes a sort of magnified pile is used, and the colour is nearly always black. These enrichments are still made here by colonies of foreigners in the back streets about Rathbone-place. Our manufacturers seized with avidity on the few patterns that are coarse, ugly, or vulgar; you can find plenty of them on expensive pianos. The Saracens, mostly inhabiting hot countries where both air and privacy are wanted, made great use of turned-wood lattice-work of an infinite variety of patterns where the close and the open were contrasted, not unfrequently containing texts from the Koran, and these again contrasted with the solid. The Chinese and Japanese, instead of ephemeral painting, use lacquer mostly of dark colour, from avanturine to black, and enrich it with gilding or colour, or with low reliefs in gold-coloured lac; the metals, ivory, mother-of-pearl, and precious stones are often inlaid, and are frequently carved and raised above the surface. The Chinese and Japanese, having once been colourists, occasionally furnish us with old lacquer in low tones that is superb. Considering how the Japanese have taken us captive by their art, it is surprising that so little use has been made of late of their fine lacquered panels; but unless we can emulate the cheap broom seller, who stole his brooms ready made, we either have not wit or industry enough to avail ourselves of that which would give piquancy to our designs.

Mr. Ruskin is not complimentary to our age, for he speaks of it in his Oxford lecture as:—"An age without honest confidence enough in itself to carve a cherry stone with an original fancy, but with insolence enough to abolish the solar system, if it were allowed to meddle with it."

Some of the Chinese black lacquered ware, inlaid with gold and black mother-of-pearl, is as beautiful as Labrador spar, and I have seen black lacquered Indian cabinets of large size, inlaid with squares and patterns of black mother-of-pearl, that are more gorgeous in colour than anything but fine stained glass.

Woven and Felted Stuffs.

Unwholesome as cotton and silk are said to be, and as all woven stuffs and some felted stuffs are, from their retaining dust, I fear we are not likely to relinquish them in our houses, so long as we can get the cheapness of calico, the sheen of satin, the bloom of velvet, or the variegated light and shade of plush, particularly as all these materials dye well.

The most original patterns on calico, and those of the most original and superb colour, were made in Java, and the lucky travellers to those parts who had taste, bought up all the fine specimens, some dozen years ago, or, at least, the more recent examples, if they be not European imitations, are not comparable to the old ones. Those exhibited are not equal to the finest I have seen. They are used by the natives as clothing; in the centre is a stripe, about one-third of the whole width, of very dark colour, mostly black or dark blue; the centre of this consists of long triangular pieces, that look as if they had been laced across, showing another garment beneath; the sides are usually of a pale yellow or a tawny colour, and are marbled with fine lines

of a darker tone, and sometimes spotted as well, and on this ground are patterns in rich dark colours, sometimes geometric, but more often of floral pattern, interspersed with birds, animals, and insects. The darker one exhibited seems to me to represent lobsters, and some spiral shell.

The designer drew on the calico the patterns, and gave the colours. All those parts of the stuff that were not of the same colour were covered with wax, and then dyed. The piece was then boiled to get off the wax, and covered with wax again, leaving those parts uncovered that were of another colour, and then another colour dyed, and so on. So that one piece was said to take years to complete.

The damask satins of the East are still woven in the primitive way that was in use before the invention of the Jacquard loom. A brother of mine who was in China described the process:—There was a scaffold on each side of the loom, on which were boys; each boy pulled up the thread of the warp that was wanted to make the pattern, and he was much astonished at the boys' and the weaver's memory, for the latter had to correct any error of the boys. But on mentioning this to Mr. Purdon Clarke, he told me that the patterns were put into verse, like our old friend *propria que maribus*, and sung by the weavers and the boys, a fine example of the mnemonic use of verse and song; and he told me there were many of these songs with their musical notation in the South Kensington Museum.

Varieties of texture and patterns too can be given in velvet, mainly by what is, I believe, called cutting, as well as by crushing the pile down into patterns by stamps; this is the method mostly pursued in those woollen velvets called Utrecht. Some of the most superb patterns and the most lovely harmonies of colour are found in the old Saracen hangings, and in those of Venice, Florence, and Genoa.

The original Arab savages, when they embraced Mohamedanism, were mainly nomads, and destitute of all arts, except perhaps eloquence, poetry, and music; vigorous in frame, inured to hardships, temperate, truthful, upright, and so passionately addicted to fighting that the Kaliph Omar said his people were as fond of fighting as the Christians were of wine and swine's flesh. They soon became learned, and addicted themselves to study geometry and mathematics. Everyone knows that the knowledge of Hindoo algebra was spread by them over Europe, and as practical geometricians they carried those geometric forms to the greatest extent, which were started by the Byzantines, so that those intricate geometrical patterns filled with floral ornament got called *arabesque*. It was through them that the mediævals got interested and instructed in geometry, and they raised all the constructive arts they found amongst the conquered to a much higher level. At first coats of mail were considered by them to be supernatural, and were called Davidian, because they invented a theory that the Almighty had bestowed on David the gift of making iron as pliable as thread. But soon the arms and armour of Damascus, Toledo, and Bilboa became celebrated throughout the world.

The Kaliphs and great men indulged in a magnificence that was then unique in the world. A short account is given by Lane of the pomp of El-Muktedir:—

"In the beginning of the year of the Hegira 305 . . . . . A.D. 927, two ambassadors from the Roman Emperor (Constantine IX., Porphyrogenitus) arrived in Bagdhàd on a mission to the Khaleefeh El-Muktedir . . . . El-Muktedir having appointed a day on which he would receive them, ordered that the courts and passages and avenues of his palace should be filled with armed men, and that all the apartments should be furnished with the utmost magnificence. A hundred and sixty thousand armed soldiers were arranged in ranks in the approach to the palace; next to these were the pages of the closets, and chief eunuchs, clad in silk, and with belts set with jewels, in number seven thousand; four thousand white, and three thousand black. There were also seven hundred chamberlains; and beautifully ornamented boats of various kinds were seen floating upon the Tigris hard by. The two ambassadors passed first by the palace of the chief chamberlain, and, astonished at the splendid ornaments, and pages, and arms which they there beheld, imagined that this was the palace of the Khaleefeh; but what they had seen here was eclipsed by what they beheld in the latter, where they were amazed by the sight of thirty-eight thousand pieces of tapestry of gold-embroidered silk brocade, and twenty-two thousand magnificent carpets. Here also were two menageries of beasts by nature wild, but tamed by art, and eating from the hands of men: among them were a hundred lions; each lion with its keeper. They then entered the Palace of the Tree, enclosing a pond, from which rose the tree: this had eighteen branches, with leaves of various colours (being artificial), and birds of gold and silver of every variety and kind and size, perched upon its branches, so constructed that each of them sang. Thence they passed into the garden, in which were furniture and utensils not to be enumerated: in the passages leading to it were suspended ten thousand gilt coats of mail. Being at length con-

ducted before El-Muktedir, they found him seated on a couch of ebony inlaid with gold and silver, to the right of which were hung nine necklaces of jewels, and the like to the left, the jewels of which outshone the light of day. The two ambassadors paused at the distance of about a hundred cubits from the Khaleefeh, with the interpreter. Having left the presence, they were conducted through the palace, and were shown splendidly-caparisoned elephants, a giraffe, lynxes, and other beasts. They were then clad with robes of honour, and to each of them was brought fifty thousand dirhems, together with dresses and other presents."

In Persia, at the present day, rich stuffs, of which clothes and hangings are made, narrow in width, sell for 25s. the ell of 3 in. in length, and some of the old Saracen stuffs must have been quite as expensive. When Saracen art and workmanship had arrived at its highest pitch, it was for the time being the best in the world, and there was a market for it in all countries.

In one of Captain Burton's books he tells us that the Saracens who made articles for the infidel markets did not like to put real texts of the Koran on their stuffs or metal work, but merely put the Kufic letters as ornaments; and when the Europeans got advanced enough to compete with them they also used the Kufic letters merely as ornament.

This practice has been the despair of antiquaries. A few years ago a correspondent at Venice sent me a rubbing of such an inscription round the neck of one of the figures of the Porta della Carta, executed in the 14th century by Bartolomeo Boni, the French sculptor, and it baffled the learning of a fine art society, until I discovered the solution given above; though I afterwards found that the late W. Burgess knew of the Christian practice 25 years ago.

In some respects even superior to these woven stuffs are the gorgeous embroideries of the East. In Athens the sacred awning of the ivory and gold statue of Athené was only allowed to be embroidered by ladies of high family, and in my first lecture I read you the account of Zumurrud, the curtain-maker.

At one time England, too, was famous for its embroidery. Considering what a paradise of idleness and novel reading England is now for the women of the upper middle-class, we may fain hope to see this charming art and industry again flourishing.

The name of spinster is now merely a joke, but at one time it was a reality; those carved oak chests, even now not uncommon in England, once contained the clothes of the bride, the thread of which she had spun; and those large gilded and painted Italian chests called cassoni, which you so often see in drawing-rooms, once served the same office.

The Empress Livia, the wife of Augustus Cæsar, though not supposed to be unversed in politics or diplomacy, spun, with the help of her maids, all the thread for her household; and we have all seen the Bayeux tapestry, in prints at least, worked by the Queen of William the Conqueror. Mr. Ruskin justly remarks that, "Life without industry is guilt, and industry without art is brutality."

The finest carpets of the East, which we all desire to have, are mostly not woven, but done with the needle. In one of the discourses of Buddha he speaks of "well-made chariots, yoked to excellent horses, and covered with carpets of elegant stitching."*

The pattern is drawn on the warp, and the carpet makers put their stitches round two of its threads, then twice tie into knots the woollen, silken, or golden thread, and cut it off. The finer carpets or rugs are not unfrequently enriched with texts from the Korân, and ornamented with lovely patterns and gorgeous colours; they take eight, ten, twelve, or even more years to make. A small rug in the Paris Exhibition of 1878 cost £1,500.

Those carpets were mostly made in rich men's houses for presents, and often by the women. A Persian in London, being shown a large modern Persian carpet, said, "What a rich man that carpet seller must have been;" when asked why, he said, "Carpets like this are only made by men's wives, and he must have had fifteen wives to have made so big a carpet."

Though Europeans mostly prefer silken, or as we should say, velvet carpets, the Easterns most value those made of the finest wool, and, I am told, use silken cords for the warp. We shall never have any fine carpets in Europe until we give up the brutal habit of walking on them with our shoes. Dirty shoes or hob-nailed boots destroy them in an incredibly short space of time, while the Mussulman carpets last for centuries, and up to a certain time they actually improve by the wear of naked feet.

Mr. Vincent Robinson, who published that splendid book on Oriental carpets, had a

* "Sutta Nipâta, or Dialogues and Discourses of Gotama Buddha" (Brâhmanadhammika Sutta). Translated from the Pâli by Sir M. Coomâra Swâmy.

woollen lustre carpet from Badakshan of a deep mahogany colour, enriched here and there with geometric patterns of blue, white, and black. The carpet looked as if it might have been the skin of the beast in the Apocalypse. The last splendid carpets that were made in Europe were, I believe, manufactured for a king of Poland in the 17th century. They were of silk velvet, intermingled with gold and silver thread, and it is said the manufacturer, Mercherski, imported Persian carpet makers for their manufacture; at any rate, he imitated the Persian and Indian examples he brought with him.

The only felted material I shall mention is paper. Felted wool or hair, though occasionally printed and occasionally embroidered, is not of sufficient importance to notice; but paper, as the commonest of all forms for applying ready-made coloured decoration, must be mentioned. The great objection to its use is that all vegetable fibre is said to absorb all ill-smelling exhalations, and as paper is attached by paste to the plastering of walls, should any damp exist it is apt to putrefy, however its absorption may be prevented by varnish.

This material is said to have been introduced about the middle of the 16th century, and almost every fine ornamental pattern of every preceding age has been used for adorning it, as well as the designs of all the able designers of the present day throughout the civilised world. To attempt to give any account of its ornament, either in form or colour, would be to give a complete account of ornamental design. I can only add that flock paper, except as a ground for painting, has the treble disadvantage of absorbing exhalations, harbouring dust, and of being difficult if not impossible to clean. Washable paperhangings are made which can be sponged with clean water, and a few that can be washed with soap.

Leather at an early age was used for tents and hanging. We read in Arrian's "Life of Alexander the Great" that he made rafts of his leather tents; and in Egyptian and Assyrian bas-reliefs we see skins blown up and used to aid soldiers in crossing streams. Doubtless leather was coloured and ornamented at a very early date, and afterwards gilt.

The Saracens who settled in Spain were celebrated for their leather work; in fact, our old name for a shoemaker—cordwainer—was derived from Cordova. Chaucer, who lived in the 14th century, described Sire Thopas as having—

"His shoon of Cordewane."

The Spaniards, who inherited their manufactories, were subsequently celebrated for their leather. Butler mentions it:—

"Some have been kicked till they know whether
A shoe's of Spanish or Neats leather."

And they were also famous for their leather hangings, which were embossed, painted, and gilt, or rather, silvered and lacquered.

The only objection to real leather hangings is their getting baggy in damp weather. Thick leather was used at a very early period for shields and defensive armour, as we know it is still by the Zulus. Amongst civilised nations all armour was ornamented. One favourite way of ornamenting thick leather was to soak the leather till it was soft, presumably in hot water, and then force it into moulds, and it was then called boiled leather, or Cuir-bouilli. Sire Thopas' greaves were of this—

"His jambeaux were of Cuirbouly."

I once saw a small panel of Cuir-bouilli of the Italian Cinque Cento, exquisitely worked, which was sold to a collector for £200.

When Japan was opened to Europeans, the Japanese were found to be the manufacturers of a material closely imitating embossed and enamelled leather, some of which began to be used in England some twenty years ago, the only objection to it being a rather offensive smell like fish oil. It was said to be made of paper, and got the name of Japanese leather paper. Since that time the old European patterns of enamelled leather have been sent out, and we now get almost any pattern we like. Enterprising men over here also started manufactures of leather paper, and it can now be got in continuous rolls of any length required, and so perfectly imitated that it can hardly be told from the original leather.

The last improvement is making it impervious to damp at the back, and with the face so firm and impermeable as to stand scrubbing with soap and water. I hope I may some day have a chance of completing this course by a sketch of the furniture and fittings of our buildings, of the personal ornaments of the people, and of the accessories which are called plate and ornaments.

But I think I have given you, in this brief sketch, a rough description of the most important ornamented and ornamental materials we have at hand, for the decoration of the out-

sides and insides of our buildings; and I have dropped a hint, here and there, of how I think they might be improved, and have drawn attention to the advantages to be obtained by a more extended use of certain natural and certain ornamental materials; but all progress must be slight unless there is a much greater cultivation of taste, greater desire for beauty, and a more general agreement of taste in some definite direction.

To some extent it is the duty, as well as the inclination, of a lecturer to find fault, when he is not a mere expounder of facts. We naturally do not need improvement if we are perfect, but if we are not perfect in those matters of which the lecturer treats he is not doing his duty if he does not find fault. Epictetus put this very well when he spoke of persons going to a physician, one has a fever, one an ulcer, one a dislocated shoulder; if the physician merely dismisses them with soft words they are at first pleased, but each takes away the malady he brought; but if the physician be a good one, he gives nauseous physic to the one, cauterizes the second, and puts the third to agony by setting his shoulder. I think persons in the present age lack the cultivation necessary to desire good workmanship and beauty, and consequently take their pleasure in lower and less ennobling ways than Nature intended, but I do not think it extraordinary.

The savage who first tied a sharp stone in a cleft stick wanted to kill his enemies and secure his prey at once; as he got security, leisure, and affluence, he shaped his weapon and ornamented it.

Our acquisitions have been the use of steam, of electricity, and of iron, on a grand scale; the application of the former in the steam-engine is more than equivalent to the labour of millions, and has enabled us to partially annihilate time and space. The rush to yoke these dragons to our cars, and to gain wealth beyond the dreams of avarice, has made us blind to the necessity of noble leisure, of beauty for our enjoyment, and for the perpetuation of our name. Even now we are like Alexander weeping for more worlds to conquer, when we have not yet conquered ourselves.

Many of the thoughtful are of opinion that the time is approaching when this wondrous application of science to the arts of life which has so completely revolutionised the world has nearly come to a close. If this be the case, and if we have not lost our energy, it will be exercised in again studying the beautiful in nature, in again beautifying what we have; and in perpetuating those evanescent beauties of our day, and those noble thoughts, actions, self denials and sufferings which are inseparable from humanity at great epochs of virtue.

If this be so, we may look to another golden age of the fine arts, which may, I hope, excel, and which I have no doubt will excel, those golden ages which have left some of their masterpieces for our instruction, admiration, and delight.

Obituary.

SIR JOHN HENRY BRAND, G.C.M.G.—The telegraphic intelligence from Cape Town announces the death of Sir John Henry Brand, G.C.M.G., President of the Orange Free State, which took place on the 14th inst. President Brand has been a member of the Society of Arts since 1875. He was elected to the Presidency of the Orange Free State in 1863, and was subsequently re-elected at the expiration of each term of five years. He was 65 years of age at the time of his decease. He was a son of Sir C. Brand, Speaker of the House of Assembly at the Cape, who died in 1875. He was a member of the English Bar, and practised till 1863 in the Supreme Court at the Cape of Good Hope.

General Notes.

OSTRICH FEATHERS.—It has been noticed that of late ostrich feathers have increased in quantity and fallen in price. This is a matter of fashion's caprice. In 1875, the finest white feathers were worth £30 the pound, three years later they sold readily, with an augmented output, at £50, and very superior realised as much as £80. At that palmy time of the industry at the Cape, a chick just clear of the shell sold for £2 10s., and the profits of ostrich farming fully rivalled those of diamond digging. The returns, however, are still considerable. The secretary of the Port Elizabeth Chamber of Commerce has supplied a record of exports from the Cape, from 1858 to 1887, whence it appears that in the first-mentioned year the quantity exported of ostrich feathers was 1,852 lbs., worth £12,688; in 1882, the trade reached its high-water mark with 253,954 lbs., valued at £1,093,989, and last year fell to an output of 266,832 lbs., valued at £365,587.—*Colonies and India.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

The Council of the Society has received a grant from the Court of the Goldsmiths' Company of £50, to be awarded in prizes for the encouragement of workmen connected with the goldsmiths' and silversmiths' trades.

On the advice of the Committee of the Section of Applied Art, the Council therefore offer the following prizes for art-workmen, in addition to those already announced in the *Journal*:—

- A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First Prize £20; Second Prize £5.
- A pendant or brooch, or locket of gold without gems. First Prize £20; Second Prize, £5.

The articles for competition must be sent in to the Society of Arts House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered are the same as those for the prizes for pottery, stone carving, and wrought-iron work, which have been previously announced in the *Journal.**

Miscellaneous.

THE FRUITS OF INDIA.

By G. Bonavia, M.D.

I.—The Mango.

I believe that mangoes are imported into England from the West Indies, and some that I have seen in the English shops appeared to be very poor specimens. An American in India told me that from the West Indies they are also sent to New York, but that they are not good. In India there are hundreds of varieties of this unique fruit. Fifty or more kinds might be named which for texture and exquisiteness of flavour would more than favourably compare with the same qualities in the nectarine and the peach. It is only those who have been a long time in India, and who have had opportunities of trying the choice varieties of mangoes, that have any conception how good this fruit is. Those who have not had opportunities of tasting good mangoes have a notion that this fruit is like so much "tow and turpentine." It would be as accurate to state that the characters of the crab apple are those of all the hundreds of apples to be found in Europe. The uncultivated seedling mangoes are generally fibrous, but this does not at all prevent their having very often an exquisite flavour. To enjoy these good seedling mangoes they must be sucked, and the native has here an advantage over the European. The former sucks his mangoes, and therefore enjoys a far more extended range of fine flavour; while the civilised European wants to eat his with knife and spoon. The choicest mangoes, of which there are scores, have not a trace of fibre in their pulp, and not a trace of turpentine flavour, except, perhaps, a *soupçon* of it in the skin. When the skin is removed, if you shut your eyes while eating them, you might often be deluded into the idea that you are eating nectarines, figs, &c., and sometimes a delicious compound with a dash of nice mushroom flavour in it. The flavours of the choice mangoes are infinite, and their size varies from that of a small hen's egg to that of a good-sized melon or ostrich egg. The colours when ripe are either citron-yellow, green speckled with yellowish dots, yellowish white, yellow with a fine crimson cheek, &c. Their shapes are either round, flat, oblong, heart-shaped, &c. A choice mango can be scooped out with a spoon, and it has the texture of a stiff curd.

Some years ago, I submitted to the Government of the North-West Provinces of India a scheme for a Mango society, with the object of studying and tabulating the fine varieties of this fruit; of making coloured drawings of them; of forming an extensive orchard, where all the choice varieties known might be collected, and propagated, for the benefit of the whole country; for learning, by experiments, the best way of cultivating and improving them, and for raising new varieties from seed. The Government of the North-West Provinces submitted my scheme to the Government of India, with the remark that they did not consider any steps need be taken in the matter, as the mango was sufficiently well taken care of by natives already. The Government of India replied that they concurred with the Government of the North-West Provinces regarding this scheme.

The mango is the one fruit tree in which natives of India really take an interest, and I thought that, under Government auspices, an extensive society

* See *Journal*, June 15.

might be got up, in which natives might take an interest, and which might eventually be the means of bringing prominently into notice elsewhere this unique fruit. Thinking that perhaps I might succeed in getting up some enthusiasm among natives regarding a Mango society, I wrote to a native gentleman, a very intelligent and educated person, about it, one of whose friends is an extensive collector of the choicest mango trees. But without the Government initiative, he and his friend had a hearty laugh over my scheme, and replied that natives were ready to eat as many good mangoes as they could procure, but, as to taking their photographs, they would leave that to European enthusiasts who cared to amuse themselves with such pastimes. Once, in Lucknow, a native gentleman, a great collector of choice varieties of mango-trees—was describing to me the exquisite qualities of a variety he had in his collection, called "Fákir-wáláh-Am." I told him to let me have a few grafts of it for the Lucknow Horticultural Garden. He said, "No, I can't do that, as when you get a plant into your hands you multiply it, and diffuse it everywhere!" This was a typical native collector. He cared nothing about philanthropy, and what he had he wished to keep for himself, not only for personal enjoyment, but to present to any official or other person whom he might wish to favour with something which everybody did not possess.

In India, mangoes are always plucked when still under-ripe, and then they are ripened completely among straw. Even the choice kinds, when under-ripe, are sour and hard; when quite ripe they are perfect, and their flavours various and unique: when over-ripe they lose their rich distinctive flavours, and are not nice.

Now I think this habit of plucking these fine fruits when still unripe might be easily taken advantage of to transport them, in cool chambers, to Europe, and then completely ripen them, native fashion, among straw, should they still require ripening, on arrival. If Australia can send to Europe its fresh fruits without any difficulty, Bombay, which is half the distance, ought to be able to supply the London markets with scores of varieties of this choice and, out of India, little known fruit. If the Atlantic can be crossed in six days by modern steamers, there must come a time when the sea voyage between Bombay, or even Karachi, and London must become much shorter than at present. It is all a matter of expenditure of coal. At present the Peninsular and Oriental Company's steamers use English coal for both voyages, but when the Indian coal mines are further developed cheap Indian coal might be used for the homeward journey, and it might then pay the company to increase the speed of their ships, and so bring Bombay and Karachi much closer to London than they are at present. Thus a trade in mangoes might be developed, not only with Europe, but also with Australia. In the meantime, a great deal might be done by holding annual shows of mangoes in Bombay, to make known the scores of fine varieties which can be grown in the North-West Provinces, Oudh, and other parts. Bombay boasts of two or three varieties—the "Alphonso," the "Pairee," and the "Fernandina"—of mangoes, and one of the best kinds is known, and is grown, all over India, under the name of the Bombay mango. But other parts of India—North-West Provinces, Bengal, Madras, &c.—might send to the show fifty or more exquisite varieties, well worth sending to London. Originally, these fine kinds were no doubt the produce of seedling trees, but by cultivation and grafting on the hardy wild seedling, and possibly by change of soil and climate, they have become much improved. At the present day the history of their origin has been lost, and now natives have so many choice kinds that they trouble themselves little with raising new ones from seed, which process would require time, space, trouble, and expenditure. I succeeded in tracing the history of a very choice mango now grown at Futtehgarh. It is called "Inayat Khan ka naudha" (this means Inayat Khan's new mango). It is rather large and round, and bursting with luscious juice. It does not cut so smoothly as the "Tikàri," an ice-cream-like variety, grown also at Futtehgarh. When the spoon is dug into this "new" mango, it is immediately filled with juice of a delicious flavour. Its name, "naudha," sufficiently shows that it has been recently raised from seed, probably by accident. I mention this particular "new" delicious mango, because natives, and Europeans also, are prejudiced against sowing seeds of good varieties in order to raise new kinds. Of course the seedling nurseries would require to be on an extensive scale, as the majority, on fruiting, might turn out hardly worth keeping.

In my opinion the choicest variety now grown in the North-West Provinces is the "Takàri" mango of Futtehgarh; the "Singra" mango of Benares is either the same variety, or one closely allied to it; both are rather flat. When ripened to perfection, and put under ice for some time, their pulp is like a delicious ice-cream, and can be scooped out with a spoon as easily as an ice-cream, or a stiff curd. The spoon does not fill with luscious juice, as in the aforesaid "new" mango; the pulp is compact, and of the consistence of ice-cream.

To show what room there is for an extensive mango trade between the Upper Provinces and Bombay, I shall quote some prices of choice mangoes. It is stated by persons in Bombay that at the commencement of the season good mangoes there sell for Rs.16 per dozen, and that, at the height of the season, the rate is Rs. 8 or Rs.9 per 100. While in favourite seasons, the choicest mangoes in the North-West Provinces sell for Rs.4 per 100. From Allahabad to Bombay, the mail train takes less than forty-eight hours. With these rates, and with such facilities of transport, there ought to have arisen, long ago, a brisk trade in mangoes between the Upper Provinces

and Bombay. While the fact is, that in the latter city the scores of fine varieties grown in the North-West Provinces and Oudh, are not known, even by name. Without Government initiative, little or nothing is ever done in India. In the fruit season there ought to be little difficulty in attaching a fruit waggon to the mail trains, and transporting the fruit, at cheap rates, to large centres of population. A writer in one of the Bombay papers states that he has himself kept "Fernandina" mangoes for fully thirty days after they were plucked. If Government thought fit to move in this matter, by instituting exhibitions of mangoes in Bombay every season, the fine varieties grown in various parts of India would soon become known, and if arrangements were made for their cheap and quick transport, a trade in this very desirable fruit might easily be started. Who can tell to what extent such a trade might be developed. With cheap canal irrigation in various parts of India, and with facilities of transport, the cultivation of mango trees would probably receive a great impetus, and an extensive trade, both local and foreign, might be the result. I believe that the fine qualities of this fruit have only to be made known in London to create a demand for it. The right mode of packing it, and the best way of carrying it without injury, would soon follow.

The fruit trade of India is hardly born yet. I have selected the mango for a commencement because there are already many fine varieties of this fruit, and as natives have taken interest in it from time immemorial, its cultivation is pretty well known. In the "Flora of British India" about twenty distinct species of *Magnifera* are described, and it is stated that there are in all about thirty species. Here, therefore, is a fine field for horticultural societies in India, and Government gardens, to help further in the development of the mango fruit. The introduction of new species; experiments in crossing them with a view of raising new varieties; the discovery of the best mode of cultivating them, with the object of obtaining the maximum amount of good fruit, and of new modes of propagating the plant, might all be left to Government gardens, the superintendents of which are supposed to understand the manipulation of plants. Natives will not be backward in taking up new modes of cultivation if they see any profit is to be made out of them, but they will very rarely initiate anything themselves.

I have no statistics of the mango trade, and I don't believe there are any. The railway officials might perhaps give some idea of the mango parcels borne by Indian railways, but a great deal of this may be fruit sent to friends by proprietors of mango orchards. Usually the fruit of any orchards in the vicinity of cities is consumed locally, and, as I have shown, Bombay does not even know by name the varieties grown in the Upper Provinces.

In the vicinity of canals and railway stations there appears no good reason why this delicious fruit tree should not be grown by hundreds of thousands. In the vicinity of large towns and cities, moreover, where there might be facilities for irrigation, there would also be the advantage of cheap manure.

I have shown how backward the trade in this fine fruit is—the one fruit in which the natives of India really take great interest. In another part I shall proceed to show how little is done with regard to a number of other fruits, and how much might be done, where facilities for fruit growing of various kinds exist, if the right way were adopted. Of course, without Government initiation, as I said, nothing new will ever be done in this line. Independent Europeans do set up cotton, flour, and other mills, and factories of various sorts, hydraulic presses, &c., without Government aid. But the object of these persons is to make money as quickly as possible and then leave the country. To introduce new fruit trees, make experiments with them, aud find out the best way of treating them in their new home requires time, patience, trouble, and expense, and the profit is not immediate. This work cannot therefore be undertaken except by Government. When they once show the way, and that there is profit to be made from fruit growing, there will be many who will take up the cultivation if facilities exist for obtaining plants. I think that a great deal of good might result if natives trained in the art of cultivation were to go about giving lectures in the large towns and cities. I would not say that any immediate result would occur; but I have a notion than when an idea gets into a man's head he cannot readily get rid of it, and it works its way *nolens volens*, and in time will change his mode of thinking. Moreover, if these new ideas were dinned periodically into the heads of natives, some of them would stick there, and eventually work some good. For instance, there are many things that natives might be induced to take up if the subject was frequently dinned into their ears. This is one of them. The leaves that fall in the autumn and winter from trees in orchards are universally swept away, and used by the grain-parchers all over India as fuel. Now it is evident to me that one of the functions of the deep roots of trees is not only to suck up moisture, but any mineral ingredients necessary to the growth of the tree. All these ingredients are again annually spread on the surface of the ground when the leaves fall. There is, moreover, in these fallen leaves, not only the ingredients of the ash, but something more, which would not only help to nourish the tree, but prevent moisture from evaporating too rapidly from the soil. This is what occurs in forests. Their own fallen leaves go on nourishing the trees for centuries. I have sufficiently shown in the Lucknow Horticultural Garden how an arid piece of ground can be turned into an almost tropical garden, mainly by means of surface leafage and irrigation; first, the leaves were brought from the outside, and afterwards the trees themselves provided this surface manure, and kept on increasing it every year. Well, I have never seen or heard of a native who ever left the

fallen leaves of his orchard to decay under his trees, or who collected them in order to make leaf mould for future use. Another thing is this, where there are facilities for canal irrigation, natives, who use this water, invariably give their ground too much of it. They think probably that as they don't pay more for taking a lot of it they may as well have it. I have seen disastrous results in fruit trees from over-irrigation. Without proper drainage the soil gets water-logged, and the trees become miserable, and perish in a few years. Other things might be suggested to serve as subjects for periodical lectures. One lecturer in the vernacular language would be able to perambulate a whole province in a year. No lecture-hall would be needed. The shelter of a tree, or a grove, or the open air would do as well.

II.—The Date Palm.

This part will treat of the usefulness of this important tree, and of its suitability to large tracts of the Indian Peninsula. To commence with, the wild date tree (*Phœnix Sylvestris*) grows all over India, from the South to the foot of the Himalayas. All along the railways, from near Madras to Bombay, and thence to Jubbulpore, I have seen it in luxuriant groups growing on the black soil of those countries. Natives eat its small, almost pulpless fruit, but the principal use they make of the tree is for extracting its sap for "toddy"-making. In Bengal, this wild date tree is grown in immense numbers for sugar-making. In the district of Jessore alone, in 1882-3, it is stated that there were 24,122 acres under date cultivation, and that the value of refined and coarse date-sugar for that year was calculated at Rs. 48,46,241 in this one district alone.

With regard to the cultivated date tree—grown for the sake of its fruit—it has existed in Sindh and the Punjab from time immemorial—some say from the time of the invasion by Alexander the Great; others say that it was introduced by the Arab conquerors of Mooltan and Sindh about the seventh century. The fact, however, remains that in the district of Mooltan alone, at the nominal rate of one anna (four farthings) per female tree, the Government realise a revenue of upwards of Rs.12,000 a-year. The date tree is grown in hundreds of thousands in Mooltan, Muzaffargarh, Dera Ghazi Khan, Dera Ismail Khan, &c., for its fruit; and the Government revenue from this date tree tax on female trees alone, for the whole of the Punjab, amounts to upwards of Rs.50,000. The date trees of the Punjab and Sindh receive no cultivation whatever; they sow themselves, and are not propagated from offsets. The consequence is an inferior date, which, although it largely feeds the people, and is exported to other parts of the Punjab, is not suited for foreign export. Some of the varieties are not unlike the Muscat dates, and with cultivation they might be vastly improved. The samples I have seen averaged from 1 to 1½ inches in length. The settlement officer estimated the average outturn of fruit per tree at from 1½ to 2½ maunds (a maund is 80 lbs.), and the price at two maunds per rupee—which would give the value of the gross produce per tree at from 12 annas to R.1 4 annas.

Now, in the Persian Gulf there are upwards of 100 varieties of dates. Some of the choicest are exported to Europe and America. This tree is there highly cultivated, and plantations of offsets from female trees alone are made, and the female flowers artificially fertilised. As in other fruit, it is not only variety but also good cultivation that produces a choice article. In the Persian Gulf, very great care is given to this tree; it is not only well manured, but irrigated regularly.

An average of five years—1879 to 1883—gives the following annual trade in dates in the Persian Gulf:—From Bushire to England, India, Java, Aden, and the Red Sea, about Rs.38,000. From Muscat to India, Yamen, Zanzibar, and America, about 769,800 dollars. From Soor, Kharyyat, and Batuah, to other places not named, about 1,539,000 dollars.

In 1868, with the aid of the Government of India, I made some experiments with date seeds and offsets of various kinds, from the Persian Gulf, in the Horticultural Gardens of Lucknow. The offsets arrived in splendid condition, packed either in sacks or ordinary wooden boxes. They had about a foot of stump, and were without any roots. They were just chopped off the parent tree, at the foot of which these offsets generally grow. About 50 per cent. of them struck root, and all the seeds germinated. A number of seeds of different varieties were also distributed to the various districts of Oudh. The result of this experiment is that, in 1884-5, in the Horticultural Garden of Lucknow, there were 112 date palms from offsets, from 12 to 13 years old: and 252 trees raised from Persian Gulf seed, from 13 to 16 years old; both these lots were fruiting. In addition, a new plantation has been recently formed, consisting of plants raised from the Lucknow acclimatised seeds. Then, in the districts of Oudh, it is estimated there are about 1,250 date palms from imported seeds.

Some three or four years ago, I found that a large number of the date trees I had planted in Lucknow were fruiting. I obtained some of the dates and found them very palatable, although they were in their unripe state—red or yellow. This stage corresponds to what in Persia is called "khárák." In this stage the date is crisp, like an apple. At first it is astringent, and then it becomes sweetish. In this stage it is largely eaten in the Persian Gulf. It is also extensively preserved by boiling it in water, and then drying it in the sun. Then it becomes what they call "khárák pokhta," or cooked dates. The latter can be kept for a year without spoiling.

Seeing that the Oudh experiment had proved a success, I brought it prominently to the notice of the local Government, and urged that, as the wild tree grew luxuriantly all over India, there was good reason to suppose the cultivated kinds would do well

in many parts of India, and that there was no reason why the choice varieties of the Persian Gulf should not be introduced extensively into India, both by seeds and offsets. I also submitted a paper on this subject to the Director of the Royal Gardens at Kew, giving all the facts then known to me regarding this fruit tree in India. On his recommendation, the Government of India took up this important matter, and from information I have obtained, this enterprise at present stands as follows:—In Lucknow and Oudh there are the old trees, which formed the subjects of the first experiment. Mr. Ridley, the present superintendent of the Lucknow Garden, has formed new plantations, or has distributed acclimatised seeds and plants.

Mr. Duthie, the Superintendent of the Botanic Garden at Saharanpore, has formed extensive plantations of seedlings imported from all sorts of places. A number of offsets he recently imported from the Persian Gulf, and which he said arrived in splendid condition, were distributed partly to Lucknow, partly to Ajmere, Oodeypore, and Jeypore, in Rajpootana, and a certain number were kept for Saharunpore. The Durbar of the Jeypore State have sanctioned the purchase of half a ton of date seeds. The Mysore Government imported a quantity of date seeds and a number of offsets from the Persian Gulf. They are mainly planted at Bangalore, and are under the care of Mr. Cameron, the Superintendent of the Government Botanic Garden there.

I have been informed that the Government of H.H. the Nizam, in the Deccan, have also imported seeds and offsets from the same locality.

Lately, the Central India Agency at Indore imported ten maunds of seeds of the four choicest varieties, and a number of offsets of the same kinds.

At the same time the Government of the Punjab imported a similar quantity of both offsets and seeds for that province.

It will be seen that the enterprise of introducing into India choice varieties of dates has been fairly started. It now remains to make the whole affair a success. In order to do so, however, it is not sufficient to import once a certain number of offsets and seeds, but the importation should, in my opinion, be kept up every year for at least ten or fifteen years. I have more faith in seeds than in offsets. The latter require more care during the first years, although they will fruit earlier than seedlings, *cæteris paribus*. It is only an Arab or a Persian who, knowing the value of an offset, is likely to take sufficient care of it to make it strike and grow into a tree. Seedlings, on the contrary, are hardier, and are more likely to adapt themselves to the various climates and soils of India. Moreover, they are much cheaper, and can therefore be obtained in larger quantities. Although it is advisable to import the identical choice varieties of the Gulf by means of offsets for general purposes, I would say it is better to import their seeds in large quantities every year for a succession of years.

I would here note that the people of the Persian Gulf despise date seeds and think them worthless, simply because they have at hand any number of offsets of the choicest kinds. They can therefore form plantations of female trees only, and artificially fertilise their flowers by the pollen of comparatively a small number of male trees, which might be grown anywhere; while it is impossible to tell the sex of a seedling before it flowers. Similarly, in India, the people despise the seeds of good mangoes, because they can obtain any number of grafts of the best kinds, which, *cæteris paribus*, would fruit earlier than seedlings.

Recently, Sir Lambert Playfair, Consul-General of Algeria and Tunis, wrote that "it is not at all necessary to send offsets from there to India, as, in the experience of the Arabs in Algeria, trees raised from seeds produce just as good dates as those raised from offsets. The only drawback," he says, "is that seeds produce an undue number of male trees." This, however, far from being a disadvantage in India, would at first be an advantage. Artificial fertilisation is not known there yet, and the larger the number of male trees at first the surer would be the crop. In due course India would possess a number of choice varieties, producing offsets of their own. Then plantations of female trees only could readily be made, and their flowers fertilised artificially, as in other places. The excess of males might then be turned to various other uses.

Sir Lambert Playfair added that from the Djereed in Tunis, where the best date in the world is grown, he despatched enough date seed of this fine variety to plant half India, and that he personally superintended the selection of the seeds. It is hoped, therefore, that some result may be obtained from his good work. Possibly, however, he may have forgotten that in India, in the dry weather, droves of hungry goats and cattle roam about the country, and, like locusts, they devour every green thing that comes in their way; moreover, the natives of India leave much to the care of God. Both these factors will account for a number of the plants raised from seed, and therefore allowance should be made for them, and the importation kept up every year, till India is sufficiently stocked with good date trees to do without any further importation.

There is, in my opinion, little doubt that many parts of India are suited to growing the better kinds of dates. All the Punjab, Sindh, and Rajputana ought in course of time to be able to supply the whole of India with this important fruit. Mooltan has an average rainfall of seven inches, while Muscat has four inches, Bushire thirteen inches, and Busrah a little more than Bushire. Moreover, it is stated that in the oases south of Algeria the date tree, in many places, grows in saline soils, the water of which, it is stated, contains one drachm of salt to the pint. Now, in Rajputana there is not only the great salt lake of Sambhur, but hundreds of salt lakelets and brackish pools, round which date trees might be planted.

Rajputana sadly wants population to develop its resources, and the date tree might yet be the means of populating it.

Mr. Ashton, of the Salt Department, informs me that on the shores of the Sambhur lake the wild date-tree grows very luxuriantly; I do not see any reason, therefore, why the cultivated date tree should not do well there also. It would appear only a matter of cultivation, and the selection of the proper varieties. Mr. Ashton has undertaken some experiments with seeds of the cultivated date on the shores of the Sambhur lake. In the saline oases of Algeria it is said that nothing but the date tree will thrive. I believe the Government of the North-West Provinces of India have also undertaken some experiments with the date tree on saline soils, such as are there called "*oosur*." I think, however, that in such soils the young plants should at first be surrounded with manured soil, in order to give them a fair start.

Further south of them, there is a tract of territory comprising the province of Mysore, the South Mahratta country, of Bombay, and a portion of the ceded districts of Madras, where the fall of rain is precarious. The introduction of the date tree in those tracts might eventually largely help to mitigate the disastrous results of the scarcity of rain. Further, there are extensive tracts in the eastern side of the Madras Presidency which do not get a drop of rain during the south-west monsoon. The rainfall in those tracts commences about November, with the north-west monsoon. As the date crop ripens in September, it will have been gathered, and probably consumed or exported, before the heavy rains of those parts commence.

It is, however, as a protection against the periodical famines of India that I would urge the date tree to be extensively grown, not only in those tracts which get little rain at any time, but also in those parts which usually get a sufficient amount of rain. The date tree is one which can stand any amount of rain, and grow luxuriantly. In rainy seasons its food would not be wanted, and might be used for feeding cattle. Then in times of scarcity, when other crops failed, it would find itself in its more congenial climate, and would provide the people with its abundant and nourishing fruit. Mr. Ridley, of Lucknow, stated that the date trees under his charge gave the best crop in 1878. In that year there had been very little rain before October.

There are, I think, popular errors connected with the date tree, which might, with advantage, be carefully and scientifically investigated.

(1) It should not be forgotten that there are probably as many varieties of dates in the world as there are of apples; that some kinds are suited to certain climates and soils, and others may be suited to very different conditions.

(2) It should be remembered that all varieties pass through the stage called "khárák" in Persia, which is either red, or yellow, or shades thereof. This is crisp, and at first astringent; at a later stage it becomes sweet and nutty, and perfectly edible in its raw state. It can, however, be boiled in water (which washes out a good deal of the tannin), and then dried in the sun. In this state is is called "khárák pokhta" in Persian, and can be kept for a year.

(3) Certain varieties of dates do not ripen beyond the "khárák" stage, and can only be preserved by boiling and drying, while others ripen to the soft and completely sweet stage, called "khoorma" in Persia. The fresh "khoorma" will not keep anywhere more than two or three days, if kept in a heap, as it turns sour and spoils. It requires to be further cured by drying in the sun. There appears to be no such thing as a whole bunch of dates ripening all at the same time. As the individual dates ripen they are either shaken down or picked off. Certain varieties, however, can be left on the tree till the whole bunch is ripe, and sufficiently dry (like raisins) to be packed and exported without further preparation.

(4) It is therefore very probable that when observers have seen that in certain climates, and under certain conditions, the fruit of the date tree does not ripen to the "khoorma" stage, they may have concluded that the fault lay in the climate and soil, while in reality it may have been that the variety was at fault. For instance, in Bordighera, they have a variety which is said not to ripen there, and this failure is attributed to climate and surroundings, while it may be the fault of the variety. In Bordighera, moreover, they use the date palm for other purposes than its fruit. They swathe its leaves in order to blanch them for church ceremonials. This is hardly the way to produce good fruit under any circumstances. In Elche again, in the Province of Murcia in Spain, there is an extensive plantation of date trees. It is evidently a variety which does not ripen to the "khoorma" stage. Its fruit, however, is there utilised somehow by grinding it into meal. Finally, at Gabès and Sarsis in Tunis, and probably in other places, there are extensive groves of date trees which, on account of the excess of the humidity, are stated to produce uneatable fruit. It is not improbable that here also the variety may be at fault and not its surroundings. In the oases south of Algeria, where the conditions are favourable to the ripening of a large number of varieties of dates, they have one which makes people thirsty when eaten. Another sticks in the eater's throat and makes him cough; it is bad, and only given to animals. A third, a good one, is ripened by being placed among straw. A fourth will not keep; it is also bad, and given to animals. Some are so full of juice that it drops out of them like honey; some are white, some remain green, even when ripe; some varieties are early, others late; some are shaped like cats' claws, &c., &c. It is enough to consult the "Bulletin Mensuel de la Société Nationale d'Acclimation de France" to see how many varieties are to be found

in the oases of South Algeria alone; 130 varieties are there enumerated, each with a distinct name. In Egypt they have about fifty varieties, and in the Persian Gulf over a hundred.

(5) The Arabs of northern Africa have a notion that, in order to have good dates, the roots of the tree must be in water, and its head in the fire—that is, surrounded by a hot dry atmosphere. This may perhaps be true in order to produce and ripen the sweetmeaty varieties of the European shops, but it is certainly not true that a good edible and palatable date cannot be produced without these conditions. Recently I sent from India to the Director of the Royal Gardens at Kew a collection of Oudh dates from seedling trees. They averaged from $2\frac{3}{4}$ inches to $3\frac{1}{2}$ inches in girth, and from $1\frac{1}{2}$ inches to 2 inches in length. Some of them reached me perfectly ripe and sweet in the stage of "khoorma." Now Lucknow, the capital of Oudh, has an average annual rainfall of upwards of 36 inches, so that at the ripening time, about September, the atmosphere there is usually very damp. The Oudh date trees to which I refer were raised from seeds of the best varieties from the Persian Gulf. One particular tree from which I received specimens had two kinds of on it, one consisting of fine large specimens, among which were ripe and perfect ones. These evidently had been fertilised, as their seeds were perfect. The other consisted of small worthless specimens without seeds. These evidently had not been fertilised. This particular tree had received a good deal of cultivation, and its perfect dates were the best of any I had received. Here, then, is a tree producing perfect dates, and at the same time also worthless ones. How many of the popular errors about dates have been caused by observers not taking into consideration that unfertilised female flowers give nothing but worthless dates it is impossible to say. In the Persian Gulf these unfertilised dates are called "shis." They are small, totally insipid, and only fit for goats. I have said enough, I hope, to show that there is a great deal to be learnt about the date tree, its fruit, and its varieties.

In conclusion, I shall quote a few paragraphs from a recent work on "Tunis: the Land and its People," by Chev. de Hesse-Wartegg, p. 278, chap. 13. "The Oasis of Southern Tunis.—Southern Tunis, on both sides of the large salt marsh—Sebcha Pharaon—which latter reaches far into Algiers, is a beautiful country of palms, which is not surpassed by anything on the shores of the Nile . . . . . This palm region *par excellence* is known in Africa under the name of 'Beled-el-Djereed,' and no fruit is valued higher than the sweet, large, and juicy Djereed date, which also fetches the highest prices in European markets . . . . . . Gaffa is the largest oasis in the Djereed district. It possesses a palm forest of about 200,000 trees, and is inhabited by from 3,000 to 4,000 Arabs and Berbers. About twelve kilometres distant from Gaffa extends, at the foot of the high steep mountain chain of Djebel Arbel, the palm forest of the oasis of 'El Gettar.' The water here is not nearly so plentiful, and camels raise it with difficulty from draw-wells; but the date palm is here so exclusively the source of livelihood of the few hundred inhabitants, that there is no choice left to them, and they must get water at any price. . . . . The number of palms in the 'Beled-el-Djereed' is enormous. The oasis of Nefzani, south of the salt marsh, contains not fewer than 300,000 trees; that of Gaffa, 200,000; in 'El Gettar' a palm forest extends over a track of land three kilometres long, and the entire region north of the 'Sebcha Pharaon' possesses no less than 1,500,000 palm trees, with as many olive, orange, and almond trees growing between! . . . . . . South of the great Shott is the extensive district of the oasis of Nefzani, with palm forests of more than 300,000 trees, and with from 18,000 to 20,000 inhabitants, living in forty villages."

Here, then, I think, is evidence enough and figures enough to show (*a*) that date trees can be grown not only where water is abundant, but where it is very difficult to get at, as in the oases of "El Gettar." (*b*) That where the date tree can be grown, under its shade, olive, orange, and almond trees can also be grown. (*c*) That a given population requires, approximately, a given number of date trees to feed it. Of course, there may be surplus produce in these oases, which is bartered for others not grown in those localities.

This is what might be had in many parts of India, viz., a forest of 500,000 date trees, with as many olive, orange, and almond trees growing under them. There is, in India, an immense tract of country—the Punjab and Sindh—eminently favourable for growing the cultivated date tree, and where already inferior varieties are grown in hundreds of thousands. Through this tract an immense river, the Indus, flows, and discharges its waters into the sea by millions of tons every hour. What would not the Arabs and Berbers of Tunis do in such a locality? and what might not be done there, in a life time, by a single person who had a head and heart for this philanthropic work? Would it not be a great work for any Indian official to be proud of having accomplished.

(To be continued).

OPEN SPACES OF LONDON.

As a sequel to "Alterations in London," which appeared in this *Journal*, vol. xxxv., p. 983, an endeavour has been made to obtain a record of the changes that have been effected in old "greens," waste ground, churchyards, and disused burial-grounds. Attention was drawn in vol. xxxv., p. 880, to the gradual planting of our thoroughfares with trees, and this, with increased attention to "window gardening," which is to be seen as well in the carefully tended window-boxes and flower-pots of the poorer districts as in the costly and brilliant floral

displays where the wealthier seem each spring and summer to rival one another, has changed much of London from its dingy and depressing aspect to one of brightness and cheerfulness. Many so-called "gardens" that front some rows of houses still show the perfect indifference of those who have the care of them for a bright outlook from their windows, and they are an eyesore to passers-by. There are some districts in which they have been quite given up, and projecting shop fronts occupy the ground. In the new suburban rows of houses, with some few exceptions, the amount of front garden is cut down to about four or six feet in depth, and the place of a back garden is arranged as a "yard," often concreted, useful for drying clothes, beating mats, or turning out the little children to play, without any anxiety about their being run over. They, however, secure front and back ventilation. But though "private" front gardens are somewhat decreasing, public gardens have rapidly increased in number and in beauty within the last ten years. "Carpet bedding" is not unfrequently spoken and written of as a "stiff and formal abomination." It has, at least, the merit of comprising much colouring into a small space, and thus affording the eye greater variation than only grass and gravel. Where the area is limited, this is of some importance. Small spaces are generally laid out somewhat formally, but bracken, ferns, brambles, and "wild flowers" have been introduced with rural effect in portions of Battersea-park. When grounds are first laid out, there is little to depend on for effect except annuals, but each year shrubs and evergreens improve. They need to be selected with due regard to soil and drainage, their nearness to shade and overhanging trees, and they require attention. In these respects there are marked improvements. No one, for example, who has a recollection of the neglected look, a few years ago, of Kennington-fields, Camberwell-green, and even of portions of Hyde-park itself, and compares that recollection with the well-kept shrubberies now to be seen, can fail to recognise the complete change. The old style of gardening, when rolling paths, clipping privet and box, mowing grass, and "tidying" up a border was thought sufficient, has given place to gardening with a knowledge of the requirements and habits of plants, and a recognition of the principles to be observed in pruning shrubs and trees. Our public parks and gardens are evidently better cared for, as well as becoming more numerous.

Churchyards.

It is believed that the first London churchyard which in recent years was converted into a garden is St. George's-in-the-East, and this was at the instigation of the rector, the Rev. Harry Jones. No doubt many of the old burial-grounds, before they were surrounded by tall buildings, had much the character of village churchyards. That several of them were planted with trees is shown by the fact that some old trees remain. The majority of them however, had, by neglect, been allowed to fall into a disordered condition, until in quite recent years there was revived a desire to make them bright with grass and shrubs and flowers. For this improvement the Metropolitan Public Gardens Association is mainly to be thanked. Several of these churchyards are now open to the public, under the charge of a caretaker, and in some of the larger ones more than one caretaker is employed.

Many churchyards have been laid out as gardens and provided with seats. In most cases where this has been done the gravestones have been preserved by placing them round the enclosing wall, or along the sides of the newly-made paths. Where no old trees existed young ones have been planted. Flower beds, and in some instances rock work, with creepers and ferns, are introduced, while the extent of turf and of shrubberies naturally depends on the size of the ground. In the majority of cases drinking-fountains have been erected. In small churchyards there has been no space for more than trees and creepers, without any attempt at garden beds. At Westminster Abbey and St. Margaret's, the old flat stones have been covered with a layer of earth, on which evenly cut grass is growing, and trees were planted along the boundary rails. St. Paul's Churchyard, which already contained some fine trees, was converted into a handsome town garden, in which a massive fountain is a prominent feature.

The following are a few of the largest and most important churchyards and burial-grounds which have been converted into gardens during the past thirteen years:—

1. St. Botolph's, Aldersgate.
2. Old St. Pancras Parish Church, seven acres with St. Giles' burying-ground.
3. St. Mary, Newington. (The old church was removed in 1876, and the clock tower as a memorial erected in 1877.)
4. St. Bartholomew's, Bethnal-green, one acre, which was opened by H.R.H. Princess Louise in 1885.
5. West Hackney, rather more than one acre, on which £540 was expended.
6. Holy Trinity, Rotherhithe, opened by the Hon. Mrs. Burges in 1885.
7. St. George-the-Martyr, Borough, 1886.
8. St. John-the-Evangelist, Waterloo-road, 1887.
9. St. John's, Hackney, which is six acres in extent, of which between two and three are arranged as garden, opened in 1886.
10. St. Mary, Lewisham, over two acres; £450 was expended on labour alone.
11. St. Mary's, Haggerston, E., rather more than an acre, 1882.
12. St. James', Bermondsey, S.E., about an acre and three-quarters. The cost of laying out was £600.
13. St. Paul's, Shadwell, one acre, opened by Lady Greville, May 27, 1886. The drinking-fountain was presented by Miss Ramsden.

14. Old burial-ground, Richmond-road, Putney.
15. St. Luke's, Chelsea, over three acres, laid out in 1887.
16. St. Martin's-in-the-Fields, Trafalgar-square, half an acre. Planted only, and provided with seventeen hexagonal seats round seventeen trees, and a drinking-fountain. Opened by H.R.H. the Princess Frederica of Hanover, May 12, 1887.
17. St. Anne's, Limehouse, five acres. There is here an ornamental fountain given by Mr. W. N. Woods, as well as a drinking-fountain by Mrs. E. Lawrence. The expense of laying out was borne by Miss T. Durning Smith.
18. St. Dunstan's, Stepney, seven acres. Opened by the Duchess of Leeds, July 18, 1887.
19. St. George's, Camberwell, one acre. Opened by Mrs. Gladstone.
20. Holy Trinity, Mile-end, one and a quarter acres. Opened by H.R.H. Princess Beatrice, May 9, 1887.
21. East London Cemetery, Mile-end Old Town, three acres; opened as a public recreation ground, 1885.
22. St. Peter's, Bethnal-green.
23. St. Mary's, Whitechapel, 1885.
24. Disused-burial ground, Baker's-row, E.
25. St. George's-in-the-East, two acres; total cost, including purchase of additional land, £4,175, 1875.
26. St. Leonard's, Shoreditch.
27. St. James, Hampstead-road, 1887.
28. St. John's-wood Chapel, 7 acres.
29. St. Luke's, Old-street, E.C.
30. St. Mary Magdalene, Bermondsey, an acre and a quarter.
31. Lambeth burial-ground, two acres.
32. St. Paul's, Rotherhithe, half an acre; opened 1885.
33. St. Paul's, Deptford, three acres; laid out at a cost of £900 in 1882.
34. Holy Trinity, Gray's-inn-road, two acres laid out at a cost of £1,200, and opened July, 1885.
35. St. Paul's, Hammersmith.
36. St. Stephen's, Battersea, planted with twenty-six trees from separate donors.
37. Paddington-street disused burial-ground, two acres and three-quarters. Over £1,000 was spent on laying out the grounds. Opened in 1886.
38. Spa-fields, Clerkenwell.
39. The Lock disused burial-ground, Borough, S.E. Half an acre.
40. The disused burying-ground, Horseferry-road, Westminster.
41. St. Mary's, Islington, opened in 1887.

Gardens and Playgrounds.

Ebury-square-garden, S.W., 1884.
Canonbury-square-gardens, N., 1884.
Carlton-square-garden, Mile-end, E., 1885.
Trafalgar-square-garden, Mile-end, E., 1885.
Northampton-square-garden, Clerkenwell.
Wilmington-square-garden, Clerkenwell.
Red Lion-square-garden.
Ravensbourne Recreation-ground, Deptford.
Recreation-ground, Haverstock-hill, N.
Playground, Winthrop-street, Whitechapel, in 1887.
Poplar Recreation-ground, opened 1867. The ground cost £9,500, the expense of laying out was £3,000, and the annual maintenance is from £450 to £500. The extent is nearly three acres. The Poplar Board of Works bore all the expense and pays the annual cost.
St. Philip's, Stepney. Three-quarters of an acre.
Brewers'-garden, London Hospital, Stepney.
All Saints', Mile-end New Town.
A part (one and three-quarter acres) of the site of Horsemonger-lane Goal.
Leicester-square. Opened in 1874.
The Green, Upper-street, Islington.
Sloane-square, Chelsea.

Several of the asphalted grounds in connection with Board schools are open to the public on Saturdays, the expense being borne by the Metropolitan Public Gardens Association.

Greens.

The following list of "greens" formerly left rough, but now attended to, does not include well-known open spaces, the commons and heaths around London, nor the larger improvements in recent times, such as Kennington, Southwark, Dulwich, Ravenscourt, and Finsbury-parks:—

Stepney, 1873.
Shacklewell-green, Hackney.
Nunhead, one and a half acres, 1882.
Goose-green, Peckham, six acres, 1882.
Paddington-green, one acre, 1864.
Camberwell-green, a well-kept garden.
Eelbrook-common. Levelled, turfed, planted with plane trees, and provided with seats.
Parson's-green, planted and provided with seats and a drinking-fountain.
Dulwich. The pond on the green converted into an "ornamental water."

In the course of inquiries as to the completeness of the above lists, it has been ascertained that the report of the Metropolitan Public Gardens Association [83, Lancaster-gate, W.] contains a list of 444 disused burial-grounds that exist or existed in London, as well as complete lists of all open spaces, including parks, commons, greens, squares, and playgrounds. The securing and laying out of most of the grounds mentioned in this article, are due to the efforts of this Association.

MEXICAN SUGAR PRODUCTION.

In Paras, Cerralvo, Agualeguas, Puntiaqudo, and Sabinas, in the State of Nuevo Leon, towns situated within ninety miles of Guerrero, and along the bottoms of the Rio Grande, as far as Matamoras, there is a considerable amount of sugar produced, but the true sugar country is situated at the towns lying along the foot of the northern declivity of the Sierra Madre, namely, Victoria, Linares, Montemorelos, Cadarrita, and numerous other towns, extending as far as the Gulf of Mexico on the South, and to the North as far as the borders of the State of Coahuila, in Lampasas, Villadama, San Buenaventura, Santa Rosa, and San Fernando. Consul Winslow, of Guerrero, says that from the cañons in the Sierra issue numerous streams which unite to form rivers, and at the heads of these rivers, where the banks are low and irrigation can be used, are situated the haciendas of sugar-cane and corn. The inhabitants of a town and owners of land, who so desire, form a company, and request permission from the Government to draw off water from the river. This being granted, the river is dammed up, and a large canal is made, which is called *el saco de agua*, or sack of water, and leading from this are smaller canals, called *sequias*, which conduct the water to the different haciendas. The *saco* of water is divided up into many shares, and each person takes as many shares as his means will permit, or each one puts so many men to work to make the dam and the canals, and according to the labour he employs is his share in the *saco* of water. The *dia de agua*, or water day, consists of twenty-four hours, or from sunset or sunrise of one day to sunset or sunrise of the next, once every month, and a man of moderate means may own but one or two days of water, while the richer haciendero may own several days, or one haciendero may be the exclusive owner of one saco of water. When a person owns one day or more of water, he has the exclusive right to the whole water for the time belonging to him, the sluice gates being shut down in the mean time from the other canals. From the same river there may be several sacos of water, but the number is limited to the size of the river. The labourers on the haciendas are, says Consul Winslow, literally worse than slaves. Their wages are generally about sixteen or twenty shillings a month, and one peck of corn and some beans every week. The tortilla, with some red pepper and beans, and an occasional piece of meat, and some coffee are the sole subsistence for themselves and families. Their bed is a sheep-skin and a cheap Mexican blanket. Besides these labourers, or *peons*, there is another class, called *arrimados*, who live on the hacienda with their families, and are allowed to plant or to raise stock on condition that they assist in the labour of the hacienda when required, or give a portion of their crop. The *medieros* are those who plant a field and give half the product to the owners. These two latter classes are much superior to the peons. If, however, it were not for the peons, no sugar-cane could be raised, as day labourers are scarce, and not to be depended upon. In the preparation of sugar, wooden mills of a rude description are generally used, although in the larger haciendas iron mills are coming into use. These iron mills are worked by water power from the canals that water the haciendas. The cane-juice is transferred from the tub to large iron boilers, which are placed over a fire in holes dug in the ground, and is boiled, being constantly stirred until it is sufficiently condensed, and is then poured into conical earthen moulds, which contain a pound each. The sugar loaves, or *piloncillos*, are then wrapped in cane leaves, and are tied with fibres from the leaves of the bayonet palm. One hundred and fifty of these loaves are packed in an oblong sack. The sugar from the different haciendas is not of uniform quality, some of it being of a yellowish-white colour, and resembling maple sugar in taste, and some of a dark brown, of a disagreeable taste. No clarifying materials are used in the preparation of the *piloncillo*. It is stated that Mexico can produce sugar at a lower price than any other country in the world. In Cuba, the pound of sugar costs the planter nearly three halfpence, in Central America a little over one penny, and in the Sandwich Islands a little over three halfpence. In the fertile lands of Mexico the production does not cost more than a halfpenny a pound at the most. There are two kinds of sugar cane planted, one called the *cana criolla*, or creole cane, which is about half-an-inch thick, of a light-green colour, thin bark, short joints, and very sweet. The other, called *cana pinta*, or painted cane, of a reddish colour, one inch in diameter, thick, with a tough bark and longer joints. The latter is mostly planted, as it yields more juice than the former. The *cana criolla* produces a much whiter and harder sugar, and of a better quality than the other, and when stripped of its bark and ground, a very white sugar is made, which is sometimes mixed with aniseed and kernels of walnuts. This class is extensively eaten as a delicacy. Consul Winslow says, in conclusion, that there are a few sugar refineries in the neighbouring State of Neuvo Leon, but from the scarcity of refineries in Mexico generally, it would be a profitable enterprise to establish them in that country.

MINING INDUSTRIES OF ASIA MINOR.

The mineral resources of Asia Minor are very extensive, but are little developed. Consul Jewett, of Sivas, states that among the known mineral deposits the following may be mentioned. In the Euphrates district—Argana Maaden—a copper mine, said to be of good quality. Keban Maaden produces argentiferous lead of good quality, also iron ore in abundance. Near Palu, three miles from the Euphrates, coal of fair quality is found. There are also in this vicinity

traces of sulphate of copper, indicating large deposits of copper ore, and extensive unworked quarries of marble and alabaster. In the Konia district the most important mineral deposits are at Bulgar and Bereketly. At the lattter place the ore is lead; at Bulgar the lead has a mixture of gold, silver, and copper. These mines are worked on the following system. The mining is contracted for by a Government commission, which pays 32 paras, or about 10d. for each oka ($2\frac{3}{4}$ lbs.) of lead. The Government pays for transport and for fuel. The forests in the vicinity having long since been destroyed, wood has to be brought from a distance of twenty to twenty-five miles. The transport of lead to the nearest seaport, Mersine, costs at the rate of about 56s. per ton, and to Constantinople, where it is sold to the Government arsenal, about £13 per ton. The lead sells for about £17 to £19 per ton. The annual output is about 100,000 okas, and this is but a small proportion of what might eventually be produced. The Bulgar mine is high up on a mountain side overlooking a deep valley in the Taurus range. There are several galleries, and the whole mountain appears to be a mass of mineral. The Government pays the miners about twopence for each dram of silver, and a trifle less for each oka ($2\frac{3}{4}$ lbs.) of lead. There are 16 dram furnaces. An oka of the ore yields about one half dram of silver. The work is carried on intermittently owing to lack of funds. The cost of each furnace holding 8 or 9 tons, for 120 hours, is said to be about £11 10s. In the Karput district are the famous mines of Keban; these have been worked for over 300 years. In former years they were a source of large revenues to the Government, but in late years the profits have largely decreased. In the Kairsarieh and Zeitoon district iron ore is found in large quantities. The villagers reduce it by a rough smelting process, and sell it at about 2d. per lb. There are no mines, the ore being found in small irregular nodules embedded in yellow clay, which covers the surface of the hills. It is never found more than a foot or two below the surface, and the ore yields about 10 per cent. of metal. The most important mines in the district of Sivas are those of Lidjessy, Kara Hizzar, and as these are carried on under the most favourable conditions practicable, Consul Jewett says that some information in detail regarding them may be of interest, as showing the conditions under which mining is carried on in Asia Minor. The mountain in which the mines are situated it traversed by two principal lodes running east and west. The mining operations consist of driving galleries or levels horizontally upon these lodes, and taking away the ore in the lode rock between these levels. The ore stuff broken in the mine contains, on an average, nine to ten per cent. of lead. The ore could not be exported in that form, as the cost of transport would exceed its value tenfold. As there are no coal mines near, or forests in the neighbourhood, smelting is impracticable, and it is therefore necessary to adopt a washing process, and this involves a loss of metal estimated at fifteen or twenty per cent. The process is as follows:— First the stone, as it comes from the mines, is passed between the steel jaws of a stone-breaker, which reduces the lumps to about the size of the fist. It then falls upon two rotating tables, at which boys stand picking out the pure ore, which need not be washed, and the dead rock which it is useless to send through the washing machinery. The remaining portion falls from the tables into tram-waggons, which are wheeled to the main building. Here the ore is passed between steel crushing rollers, driven by a 34-foot water-wheel. From the crushers it is carried through perforated revolving cylinders, which size or classify the stuff, and distribute it to fourteen self-acting jigging machines, which separate the ore from the rock by means of the agitation of water. The water works up and down through sieves, and the particles of lead, being of a higher specific gravity than the stone, sink to the bottom, while the stone is carried away over the top as refuse matter. The water from the machinery is run into catch-pits to retain the fine lead held in suspension, and afterwards into a large basin, to diminish the pollution of the river by allowing the water to become somewhat purified by settling. The work of carrying the ore to the nearest port on the Black Sea is performed by muleteers, who deliver it at the coast, about 62 miles distant, at the rate of about 30s. per ton. The raising and mine cost per ton marketable ore averaged for the year 1886—including wages, material, salaries and general charges—£10. There is a deposit of coal in the mountains near Kara Hizzar; it is a pitchy, resinous lignite, burning freely, and emitting a good flame and much gas. In burning it leaves about 40 per cent. weight of ashes and clinkers, while the lack of roads and the difficulty of access to the deposit, makes it impracticable to make use of this coal at present.

COTTON GINNING IN NINGPO.

The cotton trade of Ningpo, says Consul Scott, is interesting from the fact that it is in the production of raw cotton alone that, in that district, any use is directly made of foreign appliances. A considerable portion of the cotton produced in the immediate neighbourhood of Ningpo is now ginned by means of ginning machines imported from Japan. These machines are manufactured at Osaka, in Japan, and whether a Japanese or Western invention or adaption, are of a distinctly foreign type. It was about two years ago since they were first introduced into Ningpo, really under Chinese auspices, but ostensibly—and to discount any opposition to them that might arise from the people or officials—under the protection of Japanese. The success obtained by these machines has induced certain Chinese to

import others, and to establish a large ginning establishment on the bank of the river, some two miles from the city wall. The most important aspect of this movement is that while the machines hitherto imported have been treadle machines, to be worked by one operator, the Chinese, with the consent of the local authorities, have imported much larger machines, and the necessary boilers and engines to drive them by steam power. Should this venture meet with no opposition, it will be the first successful attempt, so far, to introduce power machinery for industrial purposes into China, apart from the Government arsenals, coal mines, and steam ships, in which foreigners have no share. The iron castings of which these machines are made, both the body and the main and subsidiary fly-wheels, although somewhat rough, are good and substantial, and they appear to do their work well and smoothly. The value of the invention consists, it is said, in the fact that the seeds are extracted from the cotton, not, as in American ginning machines, by means of saws, but by drawing the cotton between straight steel edges or knives. The cotton is fed by hand into the machines; by the movement of the machine a small portion of fibre is then squeezed between the lower movable straight edge—having a vertical movement —and the fixed upper one. The fibres of the cotton are then caught on a revolving drum of wood, faced with strips of leather placed close together diagonally. The edges of these strips are sufficiently rough to hold the cotton, which is gradually drawn between the movable and fixed steel edges, and the seeds are extracted. It is stated that two great advantages attend this method of ginning as compared with the method used in America—(1) the staple is less cut and injured, and (2) the seeds are apparently better cleaned. Consul Scott states that there is no doubt these machines are a vast improvement on anything used for the purpose in China, both as to speed and the quality of the work done. It seems probable, he adds, that in a few years they must come into general use throughout the cotton-growing districts of China, and a very large demand for them must arise—a demand that, if the principle is really of the excellence suggested, will not be confined to China, but will extend to America, India, Egypt, and all cotton-growing countries.

Obituary.

W. H. Solly.—Mr. William Hammond Solly, a member of the Society of Arts of over fifty years' standing, died at his residence, Serge-hill, Herts, on the 17th inst. Mr. Solly was the son of Samuel Reynolds Solly, F.R.S., who was also a member of the Society, and was born in 1814. He was a Justice of the Peace and Deputy-Lieutenant for the county of Hertford.

General Notes.

Production of Caucasian Wine.—Caucasian wine, though a produce known in Trans-Caucasia since the times of Noah, and very extensively produced and consumed by the native population, has only during the last few years become an article of export. The quantity shipped in 1887 to foreign countries was small, about 50,000 gallons. Much larger quantities are yearly sent to Russia proper, and considering the practically unlimited area available, and the exceptionable capabilities of this country admitting the cultivation of the vine, the actual very extensive local production of wine, and again the the improbability that a substitute could easily be found for that produce, one cannot but admit that there are some fair chances for the Caucasian wine to become a more important article of export in the future; and inasmuch as it affects the interests of the bulk of the native population, it may, in the course of time, prove a more valuable and lasting resource of wealth to this country than the now all-engrossing Baku petroleum trade. The present price of native wine varies, according to the quality of the produce, from 1s. to 2s. per gallon.—*Board of Trade Journal.*

Railway Exhibition.—The *Engineer* states that the Austrian Railway Exhibition in Vienna contains an interesting and comprehensive collection of all and every apparatus, carriage, or car used by Austrian railroads from their first beginning until the present time. Besides those various specimens, the respective length of lines and most important bridges, viaducts, and other engineering works are well demonstrated. The most interesting division is, perhaps, the one in which the rolling stock from first to last is shown. The clumsy engine of the North Railway, dated 1841, and the post-coachlike carriage of even an earlier date, look strange side by side with the magnificent steam-engine, "1888," and a saloon carriage having an outside terrace for the use of passengers, and supplied with all the latest improvements as to safety and comfort. There is also, the *Railroad Gazette* says, a transport carriage for wounded soldiers, containing the most elaborate collection of instruments, and every article in use in a first-class hospital, the whole belonging to the Austrian Samaritan Society. A state railway wagon, for the temporary electric illumination of stations along the line, is also noteworthy. Its object is to facilitate the taking up and dispatch of large numbers of soldiers and materials.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

The Council of the Society has received a grant from the Court of the Goldsmiths' Company of £50, to be awarded in prizes for the encouragement of workmen connected with the goldsmiths' and silversmiths' trades.

On the advice of the Committee of the Section of Applied Art, the Council therefore offer the following prizes for art-workmen, in addition to those already announced in the *Journal*:—

- A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First Prize £20; Second Prize £5.
- A pendant or brooch, or locket of gold without gems. First Prize £20; Second Prize, £5.

The articles for competition must be sent in to the Society of Arts House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered are the same as those for the prizes for pottery, stone carving, and wrought-iron work, which have been previously announced in the *Journal*.*

Miscellaneous.

THE FRUITS OF INDIA.

By G. Bonavia, M.D.

(Continued from p. 947.)

Part III.

In this part I shall endeavour to give an idea of the present state of cultivation and trade of various kinds of fruit.

The plantain is grown in South India by hundreds of acres, and many fine kinds are also grown in the Bombay Presidency and in Bengal. Neither do the Madras nor the Bombay varieties ever come to the Upper Provinces. The fine and aromatic red plantain of Bombay is never seen in the North-West Provinces, although the mail train takes only between 30 and 40 hours to run from Bombay to Allahabad. From Calcutta we only get, in the Upper Provinces, one variety, called "chumpa," and that, I believe, does not come for sale much higher than Benares. In Oudh and the North-West there are three varieties grown—a flavourless variety, as large as a good-sized cucumber, often cooked by natives as a vegetable, while unripe; a small variety called "kôkni," or "chini;" and the "chumpa" variety. Some years ago I introduced three new varieties from Ahmednuggur, in the Deccan. They appeared to thrive and fruit well, with shelter from hot winds. And many years ago Captain Cotton, of the European cavalry, brought with him to Lucknow, from Madras, a very choice variety. He gave me a plant of it; it did well, and produced the best fruit of all. This shows that, now there are facilities of canal irrigation, fine varieties of plantains from South India and the Deccan can be satisfactorily grown, with management, at a much more northerly latitude than was supposed. If plantains had shelter from hot winds, by means of tree screens, and if they had manure and canal irrigation, they could be easily grown in the Upper Provinces, even where the temperature in December and January went down to freezing point.

I travelled from Tutikorin to Madras, and thence to Bombay, and also to Bangalore and the Nilgiris, but nowhere did I see any pine-apples grown. If there were anything that could be easily grown in South India, I should say it was the pine-apple. I am informed that it is grown at the foot of the Khasia hills for the Calcutta market, but all we get in the Upper Provinces is the common variety, plucked half ripe, and grown in Northern India. The mangosteen, I am told, is successfully grown to a small extent on the lower Nilgiri hills.

Another fruit which is seen to some extent in the markets is the orange, and the varieties mostly grown are those of the "Suntárá" orange, a very loose-skinned variety allied to the mandarin orange, but certainly not the mandarin variety. There is some trade in this kind of orange, and I have been able to obtain some statistics of the trade in this fruit; considering, however, the extent of India, this trade is absurdly small. On the Khasia hills, it is extensively grown, principally for the Calcutta market. It is grown in a semi-wild state, and no cultivation whatever is given it. The plants are raised only from seed, and after a certain age they are simply stuck in the soil, and left to nature. They are irrigated periodically by floods from mountain rivers. These floods, it is said, sometimes rise to the height of 6 feet, in these orange orchards; but as the water

* See *Journal*, June 15.

remains there only a few hours, and the drainage is good, it does the orange trees no more harm than giving them a good soaking.

Mr. Stevenson, the Deputy-Commissioner of Sylhet, very courteously furnished me with the following statistics of the trade in the Sylhet orange:—

BOAT TRAFFIC.

	Quantity in Maunds	Value in Rupees.
1880-81..........	1,20,398	2,40,796
1881-82..........	1,46,592	not known
1882-83..........	1,02,631	1,28,288
1883-84..........	1,14,969	2,27,062
1884-85..........	1,20,884	2,47,352

This averaged about 1,21,095 maunds of oranges per annum, worth from $1\frac{1}{4}$ to $1\frac{1}{2}$ lacs of rupees in favourable years. This same orange, or varieties of it, is grown in a similar semi-wild state all along the slopes of the hills in Buxa, Bhotan, Nepal, and Kumaon.

Nagpore is another centre for growing a variety of this "Suntárá" orange. The black soil of that province appears to suit it well. The Nagpore orange is one of the best I have tried in India. There it receives a good deal of cultivation; it is budded on the common sour orange, called "khattà" by natives. They say they can get two crops in Nagpore, as they sometimes do in other places, viz., the main crop, and an after, smaller crop. The only statistics I could obtain regarding the orange traffic from Nagpore to all places, were very kindly given to me by Mr. Thomson, the Secretary to the Great Indian Peninsular Railway Company. The figures are, for 1885-6:—

	Maunds.
By goods trains..................	4,326
By passenger train	22,512
Total	26,838

Considering the suitability of the Nagpore soil to the requirements of this fine orange, that province ought to be able to supply the whole of India with it.

Delhi, then, is the third and only other centre of orange traffic, although oranges and lemons of some varieties can be grown almost anywhere in India. The Delhi "Suntárá" orange is a very delicate fruit, and a general favourite. The soil appears to suit it admirably, and that city possesses great facilities of irrigation by both canal and wells. But as the imports of oranges are very much greater than the exports, one can easily see how much there still remains to be done in Delhi regarding fruit growing. The Deputy-Commissioner of Delhi very kindly gave me the following statistics:—This orange is there also budded on the common sour kind, called "khattà," and, as will be seen further on, its cultivation is very slovenly. About 200 maunds are exported to Meerut, Jeypore, and Bombay, &c., value Rs.1,600. And from Ulwar, Nagpore, Gurgaon, and villages across the River Jumna about 2,000 maunds are imported into Delhi, valued at Rs.24,000.

With such a delicate variety of orange, such good soil, and facilities for irrigation and manuring, and, above all, such splendid and various railway communications with India as Delhi possesses, there is no reason why its orange traffic should not be on a vast scale.

I have obtained some further information on the orange and lemon trade. Bombay imports the following from Zanzibar and Muscat:—

	1884-5.		1885-6.
Zanzibar oranges	Rs.1,743	....	Rs.836
Muscat sweet lemons	Rs.1,555	....	Rs.1,695

The foregoing information was courteously given to me by Mr. Moore, the Acting Commissioner of Customs of Bombay. The Zanzibar orange is a small egg-orange, similar to that of Malta and Jaffa. It is a totally distinct variety from the "suntárá" of India. The Muscat sweet lemon is of enormous size. That Bombay should go begging to Africa and Arabia for oranges and lemons shows plainly how backward is the fruit trade of India, where almost any climate in the world may be found.

I discovered a remarkably fine orange in Gujranwàla, in the Punjab. This is neither more nor less than the famous blood orange of Malta. I knew that many years ago, before the Indian Mutiny, Colonel Clarke, then Deputy-Commissioner of Gujranwàla, had imported this orange there, but I never heard any more about it. Latterly, in studying the cultivated citrons of India, I wrote to Mr. Steel, the present Deputy-Commissioner of Gujranwàla, and made inquiries about this blood orange. To my great surprise he sent me two baskets of oranges, one containing blood oranges from the parent tree, originally introduced by Colonel Clarke, and the other with oranges from its descendants. Both were full blooded, and of a claret colour internally. Externally they were deep red, with one cheek blushed with blood. Their flavour was simply that of nectar, and could not be surpassed by any blood orange grown in Malta. He added that this orange could be kept in condition well into the hot weather; that the soil consisted largely of "kunkur," or lime nodules, of which roads are made in India. Of this stuff there are simply large tracts of country all over India. He finished by stating that this lovely orange was scarcely known out of Gujranwàla and its neighbourhood. I hastened to suggest to him that, if he could make it known in Bombay and Calcutta—with the railway communication of the Punjab with those centres of population—an enormous business might eventually be reared in this exquisite orange alone. I think Mr. Steel is now doing his

best to develop a trade there in blood oranges of the finest quality the world has ever seen. I also wrote to the secretary to the Punjab Government, pointing out what a treasure Gujranwàla possessed, and how much might be made out of this one fruit alone. He replied that the matter had been referred to the Agricultural and Horticultural Society of Lahore.

I shall endeavour now to give some idea of the fruit gardens of India, taking those of Delhi as the best samples of fruit orchards.

In the month of October, 1886, I visited the Delhi fruit gardens in search of information about the "Suntárá" orange. This Delhi orange, called either "Sintrá," or Sungtárá," or "Rungtra," is well known. I expected to find in Delhi first-rate gardens of this fine orange, considering that this place had been the head-quarters of the Mogul emperors. I was, however, much disappointed. Everywhere I saw very great slovenliness of cultivation.

The Delhi cultivators of this variety of orange say that it likes the shade of other trees, and does best under the shade of the "Bair" (*Zizyphus*). I have often observed in other places that all the varieties of the "Suntárá" orange become scorched, on the sunny side, by exposure of the fruit to the direct sun rays. The scorched fruit is almost worthless, while that shaded by the tree or among the leaves is perfect. In Delhi, however, the fact is that this orange tree is jumbled up under all sorts of trees, which may either have been there before the orchards were planted, or germinated spontaneously afterwards, and allowed to remain there. I observed among the orange bushes various sorts of ficus, tamarind, mimusops, wild mango, mulberry, bauhinia, &c., mixed up with orange trees, sweet lemon, pomelo, apple and pear trees, plantains, pomegranates, &c.

The long road from Delhi to Kurnaul is, to a large extent, lined on both sides by large fruit gardens. The forest trees, which are often allowed to remain among the orange trees, suck up manure and moisture, so that this unfortunate "Suntárá" orange tree and other fruit trees are starved or otherwise damaged.

All cultivators say that this orange tree likes a "kunkur" soil (stony soil), and there appears to be plenty of stone in and around Delhi, which in many places crops up above the surface. Mr. Lionel Jacob, ex-engineer of the Western Jumna Canal, informs me that the Delhi stone is a quartzite.

Orange growers in Delhi are unanimous in stating that well water is better for the "Suntárá" orange than canal water. They say that the fruit is sweeter in the former case than in the latter; and that the tree perishes earlier when irrigated by canal water than by well water. The latter, however, is an expensive mode of irrigation. In a large garden three or four wells are required to be worked more or less constantly for two-thirds of the year. This entails several sets of men, and several sets of bullocks, while canal irrigation is much cheaper. Mr. Lionel Jacob informs me that in Delhi, "The canal water-rate for gardens is Rs.3 2as. per "bigah," or Rs.5 per acre. In addition to the above there is the owner's rate for irrigated lands, which is half the water-rate, or for gardens, would be Rs.2 8as. per acre. The owner's rate is paid by the owner of the land, and the water-rate by the cultivator. Of course, they may be or may not be one and the same person. I should mention that the above rates are for gardens irrigated by flow: if irrigated by lift the water-rate and owner's rate is two-thirds of those noted. The gardens about Delhi are, however, almost entirely irrigated by flow. The depth of water from the soil varies a good deal. A large number of the Delhi wells are filled with canal water to make them sweeter drinking. In these, and in wells situated in irrigated lands, the water is nearer the surface than in wells at a distance from the canal. Speaking roughly, the water would be in the wells of the neighbourhood about twenty-five feet from the surface of the ground. The Delhi soil is, generally speaking, "rausli" or loam. It is probable, as cultivators say, that canal water is not so good for the "Suntárá" orange tree as well water; but, I take it, not because it is canal water, but because it is cheap, and therefore too much of it is given.

I was shown a plot in one garden which was said to have been planted some twelve or thirteen years ago with "Suntárá" orange trees, and irrigated with canal water. All the trees, they said, perished in about ten years. The plot was then replanted with "sherbetee nimboo" (sweet lemon). They say this does not mind canal water.

In another garden, newly formed, I saw orange trees which had been planted some four or five years before. They were all in a most wretched condition. I saw water lying on the surface, and was told that canal water had been given three or four days before. The ground appeared as if it had been just irrigated. It was no wonder the poor orange trees looked wretched and dying. The whole place was waterlogged, and hardly fit for even plantains. It might have suited rice.

In the Saharunpore Botanic Garden, which is irrigated by canal water, I noticed the same unhealthy condition in the citrus trees. It appeared to me the soil was too much watered. Mr. Gollam observed that all the orange trees everywhere about Saharunpore were in a similar condition. I do not know whether all these also were irrigated by canal water.

The "Suntárá" orange does not appear to mind excess of water occasionally, provided the soil be well drained. In the Khasia hills, as I said, the orange orchards are stated to become flooded for several hours, sometimes to the height of 6 feet, without any disadvantage.

In one garden near Delhi, owned by one Mohamed Shah, I saw a rather interesting mode of mixed cultivation which may perhaps be worth describing. The garden was irrigated by well water, and of course

the usual slovenliness and indifference about mixing up trees, &c., was there also in full force.

In this garden the orange trees, or rather bushes, as the "Suntárá" variety is a small tree, were mostly shaded by "bair" trees. It must not be supposed, however, that there was any system of planting. The "bair" trees appeared to have germinated spontaneously, and at a certain age grafted in the usual way with the large cultivated zizyphus. Natives say that the orange tree does best under this "bair" tree, because its time of pruning, shooting, and fruiting suit the times of the "Suntárá" orange. In this garden a third plant was associated with the "bair" and orange bushes, viz., the *Jasminum sambac*, or "Bèla."

When the "bair" trees have been grafted and grown to a certain size, "Suntárá" orange bushes are planted amongst them, and between the latter the low bushes of the "bèla" jessamine. The strongly-scented flowers of the latter are much appreciated by all natives, and find a ready sale, while the large, egg-shaped "bair" fruit is devoured in quantities in the season.

The grafted "bair" trees shed their leaves towards the end of winter. At the end of spring they are severely pruned back, and after a month or so they begin to shoot out again. Without this severe pruning, natives say, the "bair" tree does not fruit well. Pruning does not describe the process sufficiently—amputation of whole branches would do so better. At that time the orange trees begin to flower, with a minimum of shade from the "bair" trees. The soil is kept dry. During the winter the soil is turned, and left so for about two months. When the orange fruit sets manure is given, water courses and channels are made, and the ground irrigated three or four times a month. In winter, while the fruit is still on the trees, they are watered about twice a month. The orange trees and the jessamine flower about the same time. The owner of this ground said canal water is injurious because too much of it is given, and then the heat of the sun kills the young newly-formed roots—that is, I suppose, a sort of stewing of these rootlets goes on. Good drainage and less canal water would no doubt prevent injury to this fine orange.

As the young oranges swell, the vigorous new shoots of the "bair" trees lengthen, and eventually form an umbrella-shaped head to the tree. The "bair" foliage is small and not very dense, so that a great deal of diffused light reaches the orange bushes, and therefore they get just the amount of light needed, without injury to the fruit from direct sun rays. I have little doubt that if grafted "bair" trees were planted regularly, and orange bushes in alternate lines with jessamine between, it would make a paying orchard. The "bair" trees might be easily trained on one stem, with a spreading, umbrella-shaped head. I have suggested this method of shading the "Suntárá" oranges to Mr. Ridley, of the Lucknow Horticultural Garden. It has taken his fancy, and I hope he may be able to get up a neat sample-plot of this combined cultivation to show what can be done.

In making researches in Delhi about the "Suntárá" orange, I saw a number of other fruit trees which I thought very suggestive, and therefore I think it may be of some value to enumerate them, with some remarks of my own.

One kind of pear tree grows there very well indeed; it grows tall, without spreading. It is the common hard-fruited pear of the plains. To eat it raw, it might be death to any European who might venture on so rash an experiment; stewed in syrup, however, it is a very fair pear. This pear tree probably originally came from Afghanistan. It grows without any trouble. It seems almost impossible that some of the hundred or more varieties of pears known in Europe should not work well on this now almost indigenous pear tree, or even on some other stock.

Mr. Ridley, of the Lucknow Horticultural Garden, I believe has some good variety of pear, in addition to this common bullet-like one. I would not be certain that the variety I mean was not introduced there by me. All I know is that I made once an attempt to introduce there a number of European fruit trees, and planted them in the very place where I lately have seen this variety of pear tree. The head gardener told me it was much thought of, and was not the common hard kind; anyhow, there it is. Whether imported with the lot I mean, or otherwise introduced, it shows that other varieties besides the common one admit of cultivation in the plains of India.

I believe in the Government-hill nurseries at Ranikhêt they have many varieties of pears; it would therefore appear time to make some serious attempt to grow some of the better kinds in the plains.

In one of these Delhi gardens I saw some apple trees. The keeper showed, by half closing his fingers, that its fruit was about the size of a hen's egg. I know that in the public garden of Etawah there are apple trees which bear tiny fruit of a pleasant flavour. At Bangalore I saw grown there a nice small apple, about the size of a billiard-ball, which was excellent when stewed. It was called the Bangalore apple. I know also that at Ranikhêt they have some fine kinds of apples. I have tried the Blenheim pippin, grown at Sitowlee, in Almora. Considering that the varieties of apples in Europe range from 400 to 500 and upwards, there seems good reason to suppose that some of these at least would do well in the plains of India, worked on those that are already acclimatised, or otherwise.

I asked whether the jack tree (*Artocarpus integrifolia*) was grown in Delhi. To my astonishment I was told that there was one somewhere! Now, the common jack, or "kathal" tree, grows well all over the "Upper Provinces." It has dense foliage, and grows to a good height. It therefore

would do admirably, as a screen fruit tree, to protect more delicate trees from the hot winds and storms.

Plantains appear to do famously all over Delhi, yet they have there only the three common kinds before mentioned. I have shown that other fine kinds might be easily grown. Canal irrigation would just suit the plantain, and, screened by higher fruit trees, growing the better kinds ought to pay well in Delhi.

In the plains there are several varieties of edible figs (*Ficus cariac*), not very choice ones it is true, but there they are. With management some of these produce fair fruit. Other and finer varieties might be tried. All about the Mediterranean there are, at least, a dozen varieties of early and late figs, some of the largest and finest ripening in June.

Peaches, again, appear to do well in Delhi, but I do not know what varieties they have. The peach ripens during the hot winds, and if there is anything it then wants it is a moist soil and a moist atmosphere. Treated by daily watering, and by a screen of thatched grass all round the tree, I have seen excellent results produced in peach growing in Etawah, one of the driest places in India during the hot winds. In Delhi these conditions would be secured by canal irrigation, and screening by means of other tall fruit trees.

The mulberry is also largely grown in Delhi, but the trees appear to be all of one kind. There appears to be no good reason why the fine subacid and sweet large black mulberry of the Mediterranean should not be introduced. It is not improbable that it would grow like a weed there.

With pine-apples I only saw a small attempt with the common variety of the country. The Kew pine does well in Lucknow, obtained from Ceylon, and the Cayenne pine does well in Jaunpore. There would be no difficulty whatever in growing the best pine apples in Delhi under the shade of other trees.

With regard to plums, one small kind—amber-coloured—grows plentifully. It is called "Aloocha," by natives, and New Orleans plum, by Europeans. Then there is another plum-like or damson-like fruit, called "Aloo-Bokhara," which will grow almost anywhere in the plains. It flourishes in Lucknow, and fruits abundantly. Both these kinds are used for jam-making. It might be possible to introduce some of the superior varieties of plums and greengages from the Ranikhêt nurseries.

With apricots and cherries I have never seen any success in the plains. Thay do well in Ranikhêt and Almora.

As to grapes, there are some, both of the white and red varieties, which do well in the plains. But unless the rains are late, the fruit bursts and spoils from excess of water. Therefore I think the conditions of successful grape-growing in the plains of India subject to the south-west monsoon are:—(*a*) Either a late monsoon, or places which get a very scanty amount of rain; (*b*) early ripening varieties; (*c*) varieties with a thick skin which resists the bursting action of the rains.

Many years ago I sent from Sicily some grape seeds to Mr. Hodges, then my assistant in the Lucknow Garden. They produced a seedling variety, which is small, in numerous small bunches, and with a thick skin. I was told recently that this seedling grape of Lucknow never fails to bear a crop, and that its grapes do not burst in the rains. There appears room also in this direction for successful grape-growing in the plains, if the proper kinds are chosen.

Outside Delhi I saw numbers of the wild date tree (khajoor). It is very probable that the cultivated date tree would do well there also. Irrigation would be easy and cheap, and if plantations of date palms were made in regular lines, with sufficient space between them, the "Suntárá" orange tree—a shade-loving tree—might eventually be also combined with the date palm, so as to imitate the famous date forests of the Djereed, in Tunis.

The "loquat" does well in the plains of India, both at Lucknow, and at the Taj Garden in Agra, they have a very fine large variety of loquat, which always fetches a good price.

The "lichi" (*nephelium*) I did not see at Delhi, yet this fine hardy fruit tree might be grown there literally by the acre. Mozufferpur, in Bengal, is noted for fine "lichis." In Lucknow there are also good varieties. Mr. Ridley considers it a very hardy tree. It is now scarce in the Upper Provinces. I consider it so hardy that, after the first year, when it requires some care, and after it took hold of the ground, no trouble would be found in getting a good crop every year. By irrigation in the dry seasons, and manuring periodically, it will probably go on growing and fruiting for generations. Neither the frost of Lucknow (on one occasion 5 degrees below freezing point), nor the hot winds, nor excess of rain, appear to trouble it.

As to mangoes, I did not see any orchards of the grafted varieties in Delhi. They will grow anywhere in those provinces, with moderate care. There are so many fine varieties in cultivation, that it is almost impossible that some of them should not suit the Delhi soil. Canal irrigation would suit them well, although this fruit tree usually gives a good crop every second year.

Guavas, of course, are grown in most places; but some varieties are far superior to others. Lately I came across an almost seedless variety in Etawah, of which I sent rooted layers to Lucknow. Many years ago I was presented in Lucknow with some fruit of a variety which had the flavour of strawberries. I never came across it again.

Strawberries are grown in the plains during the winter in many private gardens. They might pay if grown for sale. Probably they require too much labour.

My object in reviewing the fruit gardens of Delhi is to show (1) how little is done there in the way of good fruit cultivation, and in how slovenly a manner that little is done. The present system is not even worthy of

being dignified by the name of cultivation. (2) How much more, in my opinion, might be done with the grand resources available at Delhi, and in so central a place. (3) To suggest a scheme by which Delhi—a city so admirably connected by railways with all parts of India—might become a great fruit-growing country.

My idea of a fruit garden there is this:—At present most of the fruit gardens have a stone boundary wall. If this could be made higher cheaply, so as to protect the fruit trees within it from hot winds, storms, thieves, and jackals, so much the better. If not, within the present height of wall, I would plant a row, at proper distances, of jack trees ("kathal"). Within these, again, at suitable distances, a row of mulberry trees, and within the latter a row of guava trees. This triple row all round the fruit garden would form an admirable screen for breaking the force of the hot winds and of storms, and so become an efficient protection to the more delicate kinds of fruit trees within this triple edge.

Then, if the ground be extensive, it should be again divided into squares, of certain sizes, by rows or avenues of fruit trees, such as mango, lichi, and others, which are not injured by hot winds, and which would give additional protection to other fruit trees. The squares, thus fully protected, might then be planted with good varieties of either peach, pear, apple, plum, orange, lemon, pomelo, plantain, &c., according to the fancy of the owner or the demands of the market. All kinds should not be jumbled in one plot, but a separate plot devoted to each kind, so as to suit the canal irrigation to the wants of that particular kind of fruit tree. There would then be ample space among the trees for pine-apple plants also, as these prefer a certain amount of shade.

The horticultural resources of Delhi for fruit gardening are better than those of any city in Upper India. It has a fine natural soil; it has cheap canal water. The large adjacent city and cantonment would furnish an immense amount of the best possible manures, and if the fallen leaves of the fruit trees were allowed to remain under the trees and decay there, instead of being scrupulously swept away and burnt as fuel, by the grain-parchers—a surface leaf-mould would soon be formed to protect and nourish the new and tender surface rootlets.

There would be no difficulty whatever in carrying out all that is here suggested, or modifications of it, which experience might show were needful. All that would be required would be to teach the natives the right way of setting about and keeping up a really good fruit garden. I feel certain that fruit-growing, properly managed, would be a profitable industry in Delhi. Already a considerable portion of the population is occupied in fruit growing, however rude and wasteful their mode of doing it may be. The ground, of course, would require to be so arranged as to afford ample drainage, should canal irrigation be excessive. A very simple system of drains and sluices would enable the cultivator to control the irrigation or excessive rainfall according to his needs.

All experience in India, however, has taught, and teaches, that no amount of suggestions and schemes regarding such matters will ever be taken up by natives, unless Government, or at all events Europeans, take the initiative, and show them what can be done, and the right way to do it. I shall, therefore, endeavour also to show how Government or the local authorities might usefully aid in developing a fruit-growing industry in such a promising centre as Delhi undoubtedly is.

(1.) Within easy reach of Delhi is the "Roshnàra bagh," an old decayed garden of the times of the Emperors of Delhi. I was told its extent is about 400 "begas," and that it was irrigated by canal water. It is now more of a jungle than a garden, and I was informed it was mainly used for picnics and other pleasure parties, and that it is under the municipal authorities. This ground would probably make an admirable fruit-tree nursery, with judicious thinning out of a number of the present useless trees.

(2.) My experience of public gardens in India is that they readily degenerate into places for growing vegetables and flowers for the European residents, for the supply of what are called "dâlees." This is a wasteful mode of occupying the labour of men employed in a Government or public garden; and taking everything into consideration, it is very doubtful whether this "dâlee providing" renders any profit. It is enough to go to the Taj Garden of a morning and see the number of men fiddling at the preparation of "flower dâlees," to get an idea what amount of daily labour this branch would occupy. Such vegetable and flower growing in the fruit-tree nursery I here contemplate should, in my opinion, be strictly prohibited.

(3.) As manager of this fruit-tree nursery, an Englishman, thoroughly and practically trained in fruit-tree growing and grafting of all kinds in Europe would be needed; or better, an English-speaking Frenchman, conversant with fruit-growing in France, where this industry is perhaps better understood and more economically practised.

(4.) Then the Chinese are credited with being the best and most economical cultivators in the world. The Shans, on the Indian eastern border, are also stated to be equal to the Belgians in this art. Some of these might with advantage form part of the establishment, under the European manager, to teach the natives of India the true art of cultivation, which they sadly want; and the true art for a country like India is probably the most economical.

(5.) Then the introduction of the various kinds of fruit trees mentioned, both from Europe, America, Australia, Ranikhêt, and other parts of India where they happen to flourish, should follow. The study of their various natures, their acclimatisation, the methods of rightly cultivating them under their changed conditions, should, in my opinion, form the

principal aim of this institution. The aim should be to teach the rising generations of Delhi the right way of dealing with and cultivating fruit trees, and to raise trees for native gardens. This institution would, in short, become a school for this fruit-growing industry, and an extensive nursery for supplying good fruit trees to all who desire to purchase them. Such a nursery need not be commenced on a large scale all at once, but after a commencement is made it should be capable of expansion according to needs. I would limit it strictly to fruit growing — experimenting on, improving, cultivating, and raising fruit trees only, otherwise it might easily degenerate into a general experimental ground, and the object of raising fruit trees for the plains of India defeated. The authorities often make the mistake of expecting such institutions to pay their way from the commencement. The profit of such a nursery and school would all be prospective, and ought not to be expected in £ s. d., but in a new industry, a new trade, and in general benefit to the country.

With the exception of mangoes, some oranges, a few indifferent plantains, and a few "lichis," and unripe pine-apples, there is literally no fruit fit to eat in the plains of Upper India, while Europe, America, and other countries are teeming with hundreds of varieties of delicious fruit, some of which, at all events, might be suited to the various climates and soils of the Indian plains. Even the fine white-fleshed sweet melon of Lucknow, called "chitta," is rapidly disappearing, and is being replaced by a tasteless cucumber-like melon. It is nobody's business to select seed of the best fruit for propagation, and for the sake of profit any poor melon seed is sown. In the time of the kings of Oudh, before and immediately after the Mutiny, this variety of melon was as sweet as sugar. Last year there was not one fit to eat!

With regard to the introduction of new kinds of fruit trees, without trying nothing can be known, and nothing has been hitherto seriously tried where the conditions are so favourable as I have shown them to be in Delhi. As a commercial and profitable industry good fruit-growing, in such a central and favourably conditioned place as Delhi is, I feel sure would have a great future.

With the large and growing city of Bombay, Delhi is connected by two railways; directly, by the Rajputana-Malwa Railway, and indirectly, by the East Indian Railway and the Great Indian Peninsula Railway, *viâ* Jubbulpore. With Calcutta, the great capital of India, it is in direct communication by the East Indian Railway, which now runs right into Calcutta over the Hooghly. With the Punjab, Sindh, and the North-West Frontier, it is connected by the North-Western Railway, with Oudh, the North-Western Provinces, Rajputana, Central and Southern India, it has also railway communications. If, as this Delhi fruit industry developed, the rates for carriage of fruit to Bombay, Calcutta, and other centres of population were cheapened, there is every probability that this industry would flourish, give rise to a great trade, and give employment to a large proportion of the Delhi population. I am sure there are a great number of wealthy natives in India who would readily pay for good fruit if they could obtain it, and who would be only too glad to have the trees in their own orchards, if they knew how to deal with them with advantage.

I am aware that there is a Government-garden at Lucknow, at Saharunpore, and other places, but these are of little use to Delhi for the purpose I here suggest. This city is a great centre of population, and railway communication, and should not depend on distant places for a school of fruit culture. Moreover, the gardens mentioned are used for general experimental purposes. We all know that when the manager's time and mind are frittered on fifty different things, little attention can be devoted to any special culture. We all know also that he gets little help beyond manual labour from his native subordinates, and therefore he must see everything with his own eyes. What is wanted is a manager specially trained to fruit growing and grafting alone, with a sufficient general knowledge of the art and science of dealing with plants so as to be able to make intelligent experiments, and find out a great deal that is not yet known, and to discover the right mode of dealing with each kind of fruit tree in that locality, which would become then a guide for various other parts of India.

Fruit growing for such an immense place as India is too important an industry to be left to chance, and therefore, in my opinion, it ought to have a special training place. As in Delhi there are a large number of the people already engaged in fruit growing, such as it is, it would appear the most suitable and promising locality for such an institution. Everything is there that is needed for success but the training staff and the nursery, to show the people on the spot what can be done, and to supply the right fruit trees.

BRITISH TOBACCO.

The London Chamber of Commerce has printed the report of the judges in the tobacco prize competition, the substance of which is as follows:—

"In deciding upon the merits of the various specimens of British grown tobacco forwarded for competition, we have, as far as possible, adhered to the conditions originally laid down by the Tobacco Trade Section of the Chamber when the prize was offered.

"Briefly, these conditions required that each specimen submitted for the competition should consist of a not less quantity of tobacco, grown on a commercial scale, than 400 lbs. in weight. It was also stipulated that each sample should embrace an average of the crop grown, and that such particulars should be

given by the growers as would assist the judges in making 'a report on the yet doubtful question as to the possibility of growing tobacco in Great Britain such as in quality relatively to price can compete with that of other countries.' In the first instance it was required that tobacco grown in the United Kingdom should be sent for inspection on or before the 1st of March, 1888, but in order to meet the wishes of many of the growers, the time was subsequently extended to the 1st May. This change, and the arrangements made for receiving the tobacco for greater convenience at the Fenchurch-street warehouse of the East and West India Dock Company, were the only modifications of the original conditions.

"The various entries of tobacco, numbering eleven in all, were duly inspected by the whole of the judges on the 14th May, 1888, at the Fenchurch-street warehouse. It was found that only four exhibitors had complied with the conditions of the competition, so far as quantity was concerned, but in view of the interest which is being manifested in regard to tobacco growing in the United Kingdom, we consider it desirable to present a supplementary report on the remainder of the specimens, though not properly coming within the scope of our adjudication.

"We place the four exhibits submitted to us in the following order of merit:—1st, Messrs. James Carter and Co.; 2nd, Mr. W. L. Wigan; 3rd, Sir Edward Birkbeck, Bart., M.P.; 4th, Mr. John Graves. We therefore recommend to the Section that the prize of fifty guineas should be awarded to Messrs. James Carter and Co."

Particulars respecting the various exhibits and remarks of the judges then follow, and the Report is concluded with these general observations:—

"Speaking generally, not one of the four samples eligible for the prize was in any respect valuable for trade purposes, or even merchantable, presuming that no duty was chargeable upon the article. Still it was evident that well-grown tobacco leaf can be produced upon English soil, though, of course, this admission in no way takes account of the cost of production.

"Several growers had employed three or four different kinds of seed, but in every case the type of leaf produced was always more or less alike in each separate locality, whatever seed was sown, thus indicating how powerful and controlling an influence is exerted by the soil on which the tobacco is raised.

"None of the samples submitted to us were sufficiently good to compete with foreign growths of similar grades in their then state, and most of them gave no promise of attaining it under any conditions. The exceptions to this general statement were the parcels sent by Sir Spencer Maryon Wilson and Mr. John Cairns, which, in the absence of the excessive moisture contained in them might realise in the trade something like the prices of inferior kinds of American tobacco.

"The whole of the exhibits were apparently grown last year, and for the most part were fresh, moist, and partly unripe when submitted to us. It was evident that the leaf had been cut in most cases before it had fully ripened, so that, even with sufficient fermentation, it would not be likely to materially improve either in flavour or 'burning' qualities. Even where the crop had matured before being gathered the tobacco was not marketable, owing to the process of fermentation or 'curing' and 'sweating,' being either incomplete or wholly unattempted. This process is necessary as regards many varieties, in order to obtain the proper colour and flavour, as well as to make the tobacco burn well, and it also deprives the leaf of many narcotic objections. In other words, it is an important factor in making tobacco a marketable article. The quantity grown by various exhibitors was not sufficient in most cases to allow of the process being properly carried out, but English growers will do well in future to pay more attention to a matter which foreign planters regard as being of first importance.

"With regard to the prospects of tobacco growing on a remunerative basis in England, we share the opinion that, even under the most favourable conditions possible, such a crop cannot be made to pay, and that in most seasons it must be an absolute failure and heavy loss.

"The climate of this country, to begin with, is less favourable than that of Kentucky or Virginia, and the cost of production will be found far greater here than in the United States.

"Until the curing of tobacco is perfectly well understood in the United Kingdom, the finest leaf that can be grown will be absolutely wasted and useless. In fact, in curing tobacco the 'expert' is as essential to the planter or grower as the scientific brewer is to all great breweries. Even supposing tobacco could be grown here as cheaply as in America—a point regarding which we have great doubt—the prejudice of the manufacturer and the long usage of the trade will have to be overcome before the English product can enter very largely into successful competition or consumption on a commercial scale.

(Signed) W. H. Wills,
Chairman of Committee of Judges.
W. Fream, C. Aug. Muller, } *Honorary Secretaries.*"

NATURAL GAS WELLS IN CHINA.

Consul Denby, of Peking, says that gas wells are found in Sz'chwan, near a town called Tsz-lin-tsing. In an area of twenty-seven li (about nine miles), salt wells are found. To make a well the Chinese use a long and elastic bamboo pole, supported in the middle by a crosspiece, a rope made by coupling the ends of long pieces of bamboo, and an iron instrument which weighs about one hundred catties, the

catty being equivalent to one pound and a third avoirdupois. The rope is fastened on the thin end of the pole, and the iron on the end of the rope. A slight up-and-down motion of the thick end of the pole makes the iron bore a vertical hole with its broad sharpened edge. The ground to be bored consists chiefly of sandstone and clay. When a portion of the rock is crushed, clear water is poured into the hole, a long bamboo tube with a hole in the bottom is lowered, and the turbid water raised to the top. Pipes of cypress wood are rammed in to protect the sides of the bored hole, and to prevent the water contained in the surrounding ground from gaining access to the well; the pipes are attached to each other at the ends with nails, hemp, and tung oil. The inner width of the pipes is about five inches. As the work proceeds the pipes are rammed down, and a new one attached on the top; the rope, too, is made longer. At a depth varying from seventy to one hundred chang (from seven hundred to a thousand feet) the brine is struck, and the well is fit for use. The brine is raised to the top through long bamboo tubes and bamboo ropes, and then carried to large pans for evaporation, or led to them through bamboo pipes. Besides these wells, there are others which are bored to a depth of from eighteen hundred to two thousand feet. At that distance below the surface petroleum is struck. Immediately on reaching it, an inflammatory gas escapes with great violence; work is now stopped, and a wooden cap fastened over the mouth of the pit, perforated by several rows of holes. In each of these a bamboo pipe is inserted, and through these the gas is led into the evaporation pans. The pipes ramify, and on each end a tapering mouth piece, terminating in a small aperture, is attached; the gas is then used for evaporating the brine. It is stated that the enterprising spirit which induced the Chinese to examine the ground at so great a depth is said to have had its origin in the drying up of a brine pit. The proprietors was in hopes of meeting brine at a greater depth, but found the gas instead. It is also said that when the country was infested with rebels during the Taiping rebellion, the cap was removed from one of the pits, and the gas set fire to, and it was considered nearly impossible to check the flames. The gas pits and brine wells are owned by corporations; the owners are subjected to the control of the Government.

PRODUCTION OF CAVIAR IN RUSSIA.

Caviar, which is derived from the eggs of the sturgeon (*Accipenser huso*), is an article of considerable importance in the export trade of many Russian towns and of Astrakhan, a large trade being carried on, on the Caspian Sea, the Volga, and its affluents. The *Journal de la Chambre de Commerce de Constantinople* says that from 30,000 to 40,000 pouds (the poud being equivalent to thirty-six pounds avoirdupois) are annually exported from South Russia, principally from Taganrog. The greater part finds its way to Turkey, Greece, and certain parts of Italy and Germany. But little is sent to England, and still less to France. The following is the method employed in taking the sturgeon on the Volga. The fisheries are situated at the mouth of the river, and in the rear on the land are erected large warehouses, or caves dug in the soil, and troughs extend from one end to the other to contain the strong brine necessary for the preparation of the caviar. Fishing operations are usually conducted in the spring, autumn, or winter. The autumn fisheries are considered the best, because they produce a greater supply of eggs. In the winter season the Russian fishermen fish for the sturgeon with a harpoon, a large hole being cut in the ice. During the other fishing seasons on the Volga nets are used, these consisting of a large engine composed of cables about a hundred metres long, to which are attached cords furnished with fish-hooks. These cables, fastened one to the other, are fixed at the bottom of the stream by anchors, and kept in place by beams. Each hook is calculated to be able to sustain the weight of a fish three or four metres long, and this method of fishing is very productive. Each fishing establishment is provided with boats of different dimensions. As soon as the fish are taken they are placed on board, and then transported to one of the larger vessels accompanying the fishing fleet, where they are laid down and covered with salt. All the vacant spaces between the troughs are furnished both in spring and autumn with large quantities of ice to keep the temperature fresh. After having split the head of the fish with a hatchet it is then cleaned, the belly is opened as far as the tail, and the eggs, the entrails, bladder, and dorsal nerve, called *vesiga*, which is made by the Russians into pies, and considered a great delicacy by them, are removed. All these operations last about a quarter of an hour. Before the fish ceases to writhe the eggs are made into fresh caviar, which, not being intended for exportation, is generally consumed soon afterwards. Caviar is prepared in two ways, differing very slightly from each other. For export, caviar *grénu* and caviar *compact* are prepared, and the following are the methods of preparation. In making caviar *grénu* the eggs are cleaned in water to remove the outer covering, and are then left in strong brine for about three-quarters of an hour. They are then drained in sieves placed on a kind of large inclined trench, which lets off the water into a basin. As regards caviar *compact*, the method of preparation is almost the same. After having separated the eggs from the skin and the veins, the piles of eggs are salted in the troughs, and are left about three-quarters of an hour in the brine, and while there they are kneaded in order to soften them, after which, instead of being allowed to drain off at leisure, they are twisted in cloth bags. Thus prepared, the caviar i

heaped lightly in small wooden barrels, and is ready for delivery. A third method of preparing caviar consists in preserving the eggs just as they are taken from the fish, and after lying for seven or eight months in brine, they are dried in the sun. This is the coarser kind of caviar, which, however, is very largely exported. Other substances are also extracted from the sturgeon in which a large trade is carried on. In addition to the eggs, another important product, from an industrial point of view, is the swimming bladder, situated above the dorsal spike of the sturgeon. These organs, plunged in water and separated from their external skin, cut lengthways, covered with cloth, softened by the action of the hands, made up into tablets or small rolls, constitute almost the whole of the isinglass which is consumed in Europe, and which is known under the name of *ichthyocolle*. Mixed with glue this product is of great adhesive power, and is used for uniting broken glass and porcelain. The fat of sturgeons when it is fresh is used as a substitute for oil and butter, and is largely consumed by the inhabitants of the southern districts of Russia, while the skin is used as leather, and in some cases the skin of the young fish, when it is thoroughly cleaned and well dried, is a substitute for window glass in parts of Russia and of Tartary.

THE ECONOMIC USES OF FLOWERS.

By P. L. Simmonds, F.L.S.

We are so accustomed to flowers as the showy adornments of Nature, as the ornamentation of our gardens and greenhouses, and for the decoration of our persons and habitations, that we can scarcely conceive these being consigned to common uses. But in this utilitarian age men strive to convert all natural objects into some technical employment of commercial value. Hence the fragile and beautiful flowers are distilled and prepared for their perfume, medicinal and industrial properties, and are even consumed as food.

The trade in flowering plants and cut flowers is very large in all civilised countries, especially so in those where the climate is not so favourable for their production in the open air as in tropical regions. From the south of Europe, with the facilities afforded by the parcel post, our florists and individuals now import, daily, great quantities of cut flowers for bouquets and button holes.

In great cities, especially London, Liverpool, New York, and Paris, a considerable trade is carried on in flowers. Holland sends away, annually, bulbs and flowers to the value of from £100,000 to £150,000. The tulip mania of former years is well known. As the Dutch grow large quantities of bulbs, after ascertaining the colour of the flowers, the blossoms were usually thrown away, until the demand for cut flowers in England led to shipments of these. This, however, was found to interfere with the sale of the bulbs, so the sale of the flowers has been stopped.

A cursory glance at the varied uses of flowers may not be uninteresting. Their employment for perfumes is that best known. Aromatic principles are more fully developed under sunny skies. In tropical regions most flowers possess a potency of aroma unknown in northern countries, hence the perfumer looks chiefly to warm climates for his sources of supply.

The orange, the jasmine, the rose, and the acacia thrive best in the southern parts of Europe, and the most odoriferous flowers, such as the *Pandanus odoratissimus* and the *Cananga odorata*, are to be found within the tropics. *Mimusops Elengi* is much prized by the natives of India for its fragrant white flowers, which are made into garlands. The handsome, sweet-scented, white flowers of *Mesua ferrea* perfume the air to a great distance. The perfumed flower of Soka (*Pavetta angustifolia*) are used in the East for making an essence, known under the name of "ixora extract," which has become a current article of commerce in the south of Europe. The lotus-flower (*Nelumbium speciosum*), common everywhere in India (one with a white and the other with a red flower), is highly venerated by the Hindus, and is given as a valuable offering to their gods, so are the orange flowers of the *Nauclea cadamba*.

The showy and strongly-scented flowers of *Plumieria alba*, and *P. rubra*, and other species, natives of the West Indies and some parts of South America, have a delicious odour, and are greatly valued for distilling the perfume known as frangipanni. The yellow flowers of *Melilotus officinalis*, and other species, possess a peculiar fragrancy, which is due to the presence of coumarin, an odour found in the Tonquin bean.

From the flowers of *Acacia farnesicina* is made the essence and pomade of Cassie, of the French perfumers. About 100 tons of these flowers are used at Cannes yearly, individual makers working up 100,000 pounds. The fragrant white flowers of *Blighia sapida* are used for making a distilled water. The flowers of Spikenard (*Andropogon Nardus*), under the name of Serrbel, are employed in Algeria for perfuming hair oils and cosmetics. The aromatic white flowers of Bukul (*Mimusops Elengi*) yield a fragrant water by distillation.

The rose family, of which there are so many species, is much cultivated in different localities, for the flowers to be used in perfumery as rose water or rose attar. The Provence, cabbage-rose (*R. centifolia*), will yield in the second or third year from 100 to 200 bushels of roses per acre, weighing six pounds to the bushel.

The culture of flowers is very general in Roumania; nearly every peasant has a small corner of his garden devoted to odoriferous flowers and herbs. The Kezanlik Valley there is entirely given up to the cultivation of roses. The essence made is sold wholesale in Paris at £30 to £40 per pound, but is

retailed at double that price. The rose harvest at Adrianople has been occasionally computed to yield about 94,000 ounces of attar of roses, valued at £80,000 to £100,000, but the price has declined 50 per cent. since 1883. The average of the Bulgarian rose harvests in the past ten seasons has been over 57,000 ounces. The Moors, in Algeria, extract an otto which is not without value from the indigenous musk-rose (*R. moschata*), with a double white flower.

Twenty-eight tons of rose leaves were imported into Aden in 1886, valued at £1,000, about half of which were shipped to India. The dried rose leaves which we import from the Continent are often dyed with aniline. The finest attar of roses is imported in tinned copper bottles, called "cappers." In Turkey these bottles are known as kurkoumas. The oil, sold in small gilt glass bottles, is generally much adulterated with oil of geranium or ginger-grass.

The Orientals have discovered that perfumes cool a room; hence their more general use in hot countries, as well as for counteracting miasma and unpleasant smells.

The flowers of the jasmine—the odour of which is so much esteemed by the Eastern nations—serves in northern Africa to form garlands with which the Moorish females ornament the interior of their dwellings, and they obtain a perfume by simply steeping them with oil in bottles, which are exposed to the sun. This process is also applicable to the flowers of the tuberose (*Polyanthes tuberosa*) and the cassia, the cultivation of which has been much extended, and both of which furnish delicious perfumes. The daffodil yields a delicious perfume, and mignonette is also esteemed for its fragrance. Hungary water is distilled from the tops of rosemary flowers with spirit. Lavender flowers are generally distilled with the stalks as gathered. The oil is chiefly used as lavender water, combined with orange and rose waters.

The flowers of the heliotrope emit a powerful odour, and are sometimes used for perfume.

The violet is an important perfume plant. Nice and Cannes use up about twenty tons annually, and one perfumer in Cannes distils 12,000 lbs. There are many acres of the Russian and giant violets grown at Mitcham and its neighbourhood; the first is darker in colour, but the latter is most fragrant. They are tied up in bundles of twenty-five, and are sent to Covent-garden market, from whence they pass into the hands of the retail flower girls.

Orange flowers, as a perfume, have no equal. When placed in tin cans and sealed up they have reta ed their odour unimpaired for many months. In the south of France orange blossoms are largely collected. Nice alone uses up 120 tons annually, and one perfumer in Cannes purchases 140,000 lbs. From the flowers the essential oil of neroli is obtained. Orange-flower water is largely imported from the south of France. It is one of the most agreeable vehicles for nauseous medicines that we have.

Rosebuds brought from the gardens of Tayf form a large article of trade in Djedda and Mecca. The people, especially the ladies, not only steep them in the water used for their ablutions, but boil them in sugar and make a preserve of them. The blossoms of the shaddock or pumelo (*Citrus decumana*) are used for flavouring sweetmeats. The calyces or flower bracts of the roselle, or Indian sorrel (*Hibiscus sp.*), as they ripen, become fleshy, and being of a pleasant acid taste, are made into tarts, jellies, and refreshing drinks in India.

The petals of flowers are much used in Roumania for flavouring preserves; violets, lime tree flowers, and roses are especially used. Having regard to their flavour, delicate odours, and agreeable appearance, the variety made is almost infinite, there being upwards of 150 kinds of preserves and confections made in that country.

(To be continued.)

COMMERCIAL MUSEUM AT ANTWERP.

Consul General Grattan says that the project of founding a Commercial, Industrial, and Ethnographical Museum at Antwerp, on a scale likely to prove useful to persons engaged in commerce and manufactures, arose at the time of the Antwerp International Exhibition of 1885. At the request of the municipal authorities, the Royal Geographical Society of Antwerp undertook to examine into the matter, and a committee was appointed to report upon the subject. At a meeting of the town council, held in October, 1885, it was made known that the French Government had very generously conveyed to the town of Antwerp, as a gift for this purpose, the handsome and spacious building which had been employed during the Exhibition as an annex to the French Section for the display of products furnished by the French colonies, and known as the "Pavillon de Cambodge." A Commission was then formally appointed, of which M. L. de Warl, the burgomaster, was president, and M. Alfred Geelhand, a member of the Provincial Council, honorary secretary. Annual subsidies were granted to the undertaking by both the town and the province, and the building was finally inaugurated on the 4th August, 1887, in the presence of the local authorities, the consular body, and the representatives of the Central Government. The space occupied by the Museum covers about 1,100 square metres, and a large portion of the building is already occupied by exhibitors. Amongst the countries exhibiting are Belgium, Germany, France, Russia, Sweden, and Norway. Portugal exhibits wines, Spain mineral products, and Turkey stuffs and fancy wares. There are, as yet, few exhibits from the United Kingdom, and none from the Cape of Good Hope and India. The museum is open daily from 10 a.m. to 1 p.m., during which time the Secretary is in attendance,

and prepared to give full information respecting the products, &c., to all applicants. An intelligence department, for the information of intending emigrants, is now attached to the building. Consul Grattan says that he will be glad to place himself at the disposal of such manufacturers or others in England who might wish for further information on the subject of this museum, and adds that in case English manufacturers might wish to avail themselves of this opportunity of making their goods known in Belgium, space to the extent of about 30 metres superficial measurement might possibly still be obtained to form a British compartment similar to that of Germany. Two other commercial museums already exist at Antwerp, that connected with the Antwerp *Institut Supérieur de Commerce*, as well as a very interesting one attached to the Jesuit College of Saint Ignace.

Correspondence.

RAILWAYS IN ASIA MINOR.

Among subjects of great national importance at this time is that of the continuation of the railway route to India through Asia Minor, on which information is given in the *Journal* at page 918. It has been dealt with by me in these pages from the year 1860, when I followed Sir Macdonald Stephenson as honorary advocate in promotion of the routes.

The completion of the European portion to Constantinople and Salonika is an event of greater moment than has been acknowledged. A political result has been to divert the attention of Russia to the Turkestan Railway. It is now possible for the central powers to pour troops into Roumelia, so as to check the Russians in the invasion of Roumania, Servia, Bulgaria, or Constantinople. Thus these regions are preserved in the interests of peace, and their industrial and commercial development is protected.

This, again, is a further guarantee of peace, because their development will stimulate the continuation in Asia Minor. This is also promoted by the advance of railway extension on the coast. At length the interior is being penetrated by the Smyrna and Aidin lines, the Smyrna and Cassaba lines, and the Tarsus and Mersina line. It is their advance which has induced the Porte to grant them concessions, &c., and to be earnest about the Ismid line.

It is deeply to be regretted that since the time of Lord Palmerston our authorities have taken no practical interest in the matter, and that the Porte had been left without judicious advice and encouragement at a period of great political and financial pressure. Left to contend with the adventurers of its own country and of Western Europe, the Porte has granted concessions which have not been carried out, and sought to relieve its necessities by levying money on concessions.

In this it has been encouraged by the adventurers who beset it, and who offer any conditions to obtain concessions which they hope to sell in the west. The progress of railway extension in Western Asia Minor has been delayed till this year by the Porte requiring premiums from the companies, and from the Cassaba Company a very large sum was received for prolongation of the existing concession.

Nothing can be more prejudicial to the Porte than this policy; but it has been led to believe that railway and mining concessions are very valuable, whereas, in fact, they must be a heavy burthen on those who have to provide the capital for working. For twenty years negotiations have been set up to work the Herublea coal mines on most onerous conditions. It is questionable whether an enormous outlay is not required to put them in working order. It is now reported that the Bulgh silver lead mines described in the *Journal* have been abandoned by the leading houses disposed to engage in them, on the ground that by bad working they have become unprofitable. Into the further consideration of the subject I propose to proceed on a future occasion.

HYDE CLARKE.

General Notes.

CAST-IRON PRODUCTION.—The following particulars of the world's production of cast-iron are from the *Revue Universelle des Mines*. In 1800, the production of cast-iron of the whole world was 838,000 tons; in 1885, it was 19,406,000 tons. During the period comprised between 1875 and 1886, the increase of production, calculated for the year of greatest production, was:—In the United States, 456 per cent.; in Germany, 237 per cent.; in Austria, 152 per cent.; in England, 76 per cent.; in France, 64 per cent.; in Belgium, 63 per cent.; and in Sweden, 53 per cent. Great Britain produces more than the United States, which, in return, consumes more cast-iron and steel. The consumption of the United States is, at the present day, one-fourth of the cast-iron, and one-third of the steel produced by the entire world.

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Proceedings of the Society.

CANTOR LECTURES.

OUR MILK, BUTTER, AND CHEESE SUPPLY.

By Richard Bannister, F.I.C., F.C.S.

Lecture I.—Delivered April 9, 1888.

The object of this short course of lectures on the familiar subjects upon which they treat, is to note the changes which have taken place in the origin and supply of milk, butter, and cheese, the circumstances and commercial conditions which have produced these changes, and what may be done to raise the agricultural industry of this country from its present unsatisfactory position to the level attained by dairy farmers in other countries. Moreover, the Council of this Society has extended its syllabus of examinations to include certain branches of practical and commercial knowledge, the two subjects for this year being the commerce of food and clothing. I was only carrying out the intentions of the Council in a practical form, when I undertook to bring before you the subjects treated in this course of lectures, and nothing but good can come from a movement which will compel candidates to study commercial questions from all sides, and direct their studies to those sources of practical knowledge which fit them for the battle of commercial life.

A study of the Trade and Navigation Returns shows that, year after year, the supplies of butter and cheese from foreign sources are increasing, and some countries, which twenty years ago exported but little agricultural produce, now do it on a large scale, the reason for this change being that the quality has vastly improved when compared with the butter and cheese made at home. Denmark, for instance, which twenty years ago exported bad butter of £420,000 annual value, last year exported excellent butter of the value of £2,600,000, which represents a six-fold increase in the period named. The improvement in quality has been mainly wrought by a judicious expenditure of a sum not exceeding £11,000 a year in providing the country with dairy schools, where the pupils are trained in the theory and practice of dairy work, and are taught to make butter and cheese of best quality during all seasons of the year.

Here, through the Science and Art Department, there is an expenditure on school grants now reaching £5,000 a year, but the progress made is so slow as to be scarcely appreciable. It is notorious that the teachers get their knowledge from books and not from practical observation; that theories long exploded are still taught as absolute truth, and that a slavish adherence to old text-books is the rule rather than the exception. The consequence is that there is a very poor return for the money expended, and the short-comings of the present system of teaching agriculture have caused many interested in practical agricultural education to turn their attention to the subject, and learn from the experience of other countries what can be done to combine in the best and cheapest manner theoretical and practical instruction. Much good has been already accomplished in this direction, and much more benefit will be conferred on our agriculturists by putting into practice the admirable suggestions of Sir R. Paget's Commission on Agricultural and Dairy Schools, and which are founded on the successes achieved in other countries. It is not surprising that with this lack of knowledge of first principles, our agricultural industries should have suffered longer and more acutely than any other branch of national production. Prices have fallen till farmers cannot work at a profit; the value of land has diminished in consequence, till it cannot now change hands at a remunerative rental. Foreign competition has done much to bring about this state of things, but the acute stage of the depression has been mainly caused by the inability of our agriculturists to send their dairy produce into the market in the best condition, or of the quality of the foreign product.

Before the development of our railway and telegraph systems of communication to their

present condition of perfection, the distributor and consumer of agricultural produce had to depend upon local supplies for the more perishable portion. Consequently prices for the same article fluctuated very violently according to the temporary relation existing between supply and demand. Now, however, the telegraph and the railway make the markets of the world common property, prices have been more generally equalised, and the consumer has got his goods cheaper and better than before these facilities were open to him. The supplies of milk, butter, and cheese are not therefore derived from the same old sources, local causes and competition have effected a change, and the area of supply has been very largely extended. The changes made do not apply with equal force to milk, butter, and cheese, because they are not of the same stability of composition, and while milk soon decomposes, and must therefore be locally consumed, butter can be obtained from a more extended area, and certain descriptions of cheese can, without risk of damage, be sent from one part of the world to any other where wanted. But as the dairy farmer has the choice of selling his milk as such, or of turning it into butter or cheese, it follows that this choice will be generally controlled by the best return yielded for the time being, and in special cases by the available capital at the farmer's disposal. There has of late years been a tendency to banish cheese and butter-making from the dairy on account of the trouble it gives, and the risk run in making a good article. Many farmers think that the salary of a good dairymaid is too much to pay, and they try to make butter and cheese on old lines without skill and system. Sometimes the dairy products so made may, from exceptional circumstances, command a fair price, but in the long run skilled labour must win, and it is evident from our present agricultural depression that foreign competition in butter and cheese is steadily but surely strangling our home trade, by giving us butter and cheese of the quality suited to the taste of the consumer. A trade in a particular article may be easily lost, but to to get it back again is a matter of great difficulty, and this is the bitter experience of those farmers who are now alive to the requirements of the consumer, and who see that but little can be done to improve the dairy farmers' condition till he is better educated in his work, and able to combine with his practical knowledge sound technical training.

Tables I., II., and III., give statistical information respecting the number of milch cows kept in the countries named, and also the ratio between cows and the population :—

TABLE I.—COWS IN VARIOUS COUNTRIES.

Year.	Austria.	Hungary.	Belgium.	Denmark.	France.	Germany.	Holland.	Italy.	Norway.	Sweden.
1850......	...	...	...	...	...	...	...	..	...	...
1860......	...	...	...	...	...	...	...	...	...	...
1865......	...	...	...	...	...	...	...	...	690,777	...
1866......	...	...	738,732	811,831	...	...	...	...	...	...
1869......	3,829,136	...	...	...	...	...	...	...	...	...
1870......	...	2,052,488	...	...	...	...	979,680	...	...	1,231,477
1871......	...	...	...	807,513	...	...	...	...	...	...
1873......	...	...	...	...	...	8,961,221	...	...	...	...
1874	...	...	...	...	...	...	...	1,380,380	...	...
1875......	...	...	...	...	7,315,222	...	...	...	741,598	...
1876......	...	...	...	898,012	...	...	...	...	...	...
1880......	4,138,625	2,035,217	796,178	...	7,113,242	...	908,000	...	...	1,409,236
1881......	...	...	...	898,790	7,290,827	...	884,900	2,366,556	...	...
1882......	...	...	...	...	7,261,726	...	878,900	...	...	..
1883......	...	...	...	...	7,463,243	9,087,293	876,600	...	...	1,456,504
1884......	...	1,806,177	...	...	...	...	890,168	...	...	1,492,977
1885.....	...	...	...	...	6,414,487	...	...	...	...	1,525,477
1886.....	...	...	...	...	...	...	...	...	...	...

Russia, no return of cows.

TABLE II.—COWS AND HEIFERS IN MILK OR IN CALF.

United Kingdom.

Year.	Great Britain.	Ireland.	Total.
Average. 1867-70 ...	2,119,715	—	—
1871-75 ...	2,204,222	—	—
1877.........	2,207,017	—	—
1878.........	2,208,297	—	—
1879	2,255,236	—	—
1880.........	2,241,708	—	—
1881.........	2,270,268	—	—
1882.........	2,267,175	1,398,905	3,666,080
1883.......	2,306,082	1,401,672	3,707,754
1884.........	2,390,863	1,356,585	3,747,448
1885.........	2,530,197	1,417,423	3,947,620
1886.........	2,537,865	1,418,644	3,956,509
1887......	2,536,280	1,391,987	3,928,267

United States and Canada.

Year.	United States.	Year.	Canada.
1850.........	6,385,094	—	—
1860.........	8,585,735	—	—
1870.........	8,935,332	—	—
1880.........	12,443,120	1881...	3,514,989
1882.........	13,125,685	—	—
1884.........	13,904,722	—	—
1885.........	14,235,388	—	—
1886......	14,522,083	—	—
1887......... (Jan. 1888)	14,8[illegible]6,414	—	—

TABLE III.—POPULATION AND COWS IN THE COUNTRIES NAMED.

	Population in millions.	Cows in millions.	Population to one cow.
Australasia	1·9	8·2	[1 to 5 cows.]
Denmark	2·0	0·9	2·2
Canada	4·8	1·8	2·7
Sweden and Norway...	6·5	2·3	2·8
Ireland	4·8	1·4	3·4
United States	60·0	14·5	4·1
Holland	4·3	0·9	4·8
Germany	46·8	9·0	5·2
France	38·2	6·4	5·9
Austria-Hungary	39·2	5·9	6·6
Russia	87·8	12·4	7·0
Belgium	5·8	0·8	7·2
United Kingdom	36·7	3·9	9·4
Great Britain	31·9	2·5	12·6
Italy	28·4	1·8	15·8

As we require for our annual consumption much more milk products than can be supplied by ourselves, we are largely dependent upon foreign countries for butter and cheese, and the Table given under these two heads in subsequent lectures will show the quantity and value of our foreign supplies from the time that the Customs duties were abolished to the present time. But though very little milk is now obtained from foreign sources, except when preserved in some way or other, yet the source of the milk supply of our towns has greatly changed during the last twenty years, and for reasons which are obvious enough even to the casual observer.

Before the outbreak of the cattle disease in 1866, by far the larger part of towns' milk was obtained from town dairies. The cattle lending themselves best to artificial town life were imported Dutch cows, which, while giving a fair supply of milk, grew fat, and by the time they became dry, were fit for the butcher. Whether it was due to the artificial mode of life or to inherent-predisposing causes in the breed itself, it is recorded that the cows of town dairies suffered more severely than those of country districts. Thus in London, within the Metropolitan Board of Works area, of the 9,531 cattle enumerated in March, 1866, 5,357 were attacked by the plague before the end of the year, and of these only 375 recovered; 2,295 were slaughtered to prevent the spread of the disease, 1,879 only remaining in a healthy condition. In the extra metropolitan counties of Surrey, Kent, Middlesex, and Essex, of 149,492 cows, 7,652, or 5 per cent., were affected, and 2,339 killed to prevent the spread of the disease.

The lesson thus learned of the unhealthiness of town-fed cows, as compared with those fed in a natural way, caused the sanitary authorities to impose such regulations for keeping in proper condition town dairies, that those who had ample means kept as few cows as possible, whilst many who had suffered from the effects of the cattle plague were too impoverished to start again, and the dairies, from one cause or another, have greatly diminished in number and size, till now a town dairy consists principally of a few cows kept

for invalids' or children's use. The bulk of the milk distributed is drawn from country dairies, and the volume and extent of the trade are fairly indicated by the familiar cans seen at every railway station, and which are in use for transporting milk to London and other populous centres. The railway milk truck is now an institution, and at certain hours of the day it forms part of every local passenger train to convey the full milk cans to town or the empty ones to the country stations.

When the trade began, many frauds were practised on the consigner of milk. A milk walk requires very little capital to work, and consequently milk selling is a trade taken up by people of very small means. Such persons, by offering slightly higher prices for milk than the large dealer, often obtained supplies from the small or unsuspecting farmer for which they never paid. Frauds thus became general, and the incidence of them has had the effect of concentrating the country milk business, a few large firms only being engaged in the trade. They in their turn supply the small distributors whom they know, and through this organisation the trade has become more healthy.

This method of centralisation has its advantages and disadvantages. The consigner generally gets the money for the milk supplied; but from the small number of wholesale firms engaged in the trade, the competition is small, and consequently the prices obtained are usually low and scarcely remunerative. The instability of the milk is often used as a lever for keeping down prices, because when the supply is bountiful there is a tendency to reject milk for the slightest fault of quality or soundness; and on account of its perishable nature it cannot be returned in a marketable condition. These difficulties between buyer and seller have led to the formation of Dairy Farmers' Associations for protecting the interest of members. Some of them have been sucessful in raising prices and obtaining concessions from wholesale firms they did not before enjoy. Any hardship is taken up by the secretary of the association concerned, and the relations now existing are fairly just and equitable. This effort of self-protection has also been directed to other channels, according to the requirements of any particular district; and associated dairies, creameries, and other methods of co-operation have been utilised to enable the farmer to turn to best account the milk produced on his farm.

As will be referred to more fully, the wholesale dealer has to draw his supplies from different farms and districts, and he finds from experience that the milk varies greatly in composition, even when not tampered with, and, consequently, to ensure uniformity of quality, he is compelled to mix all together. From what has been said, it will be apparent that the wholesale dealer, to obtain proper value for money, has to carefully check the quality of each supply, to see that none of the consigners of milk dilute it with water or deprive it of cream before despatching it to him. This necessity for close supervision, and the incidence of the Sale of Food and Drugs Act, have driven the producer and the distributor of milk, for self-preservation, to adopt such methods of milk examination as are refined enough for their purpose. Each of these classes knows the variable composition of natural milk, and, as a matter of course, each works in its own way to obtain the greatest benefit to itself. But as some time must be expended on the examination of samples taken from the consignments of milk, the wholesale dealer generally safeguards himself by entering into a contract with the farmers, which contract not only regulates price and quantity but also quality as well. For instance, in a Contract Form before me, the consignee insists on the milk being delivered by certain trains twice a day, that each meal of milk is to be sent away fresh, that no mixed milk of two separate meals is to be sent, that milk is to be properly strained, and that it must be thoroughly cooled over a refrigerator immediately after milking, the temperature on its arrival at its destination being a presumptive proof whether it has been so cooled; and then to make security doubly sure the last stipulation is, that the milk must contain a minimum quantity of "fat," and "solids not fat," as determined by the purchaser's analyst, whose decision shall be final.

In addition to these regulations as to the quality and condition of the milk, the contract is made subject to the sanitary conditions of the farm being entirely satisfactory to the contractor's inspecting engineer, and the local medical officer, and to be so maintained. With such regulations the public are very fairly safeguarded against the danger of a tainted milk supply, and considering the quantity of milk daily imported into, distributed, and consumed in our large towns, it speaks well for the dairy farmers engaged in the town milk trade that very seldom can disease be traced to the milk supply. The price must, however, be increased by the severity of these regulations, but the public

expect it, and consequently there is little grumbling. In London, as compared with large towns in the north of England, the price of milk is unduly high. In Manchester, Leeds, Liverpool, and other northern towns the price of whole milk varies from threepence to threepence - halfpenny a quart, but in London the price is never below fourpence, and in most districts fivepence a quart. It cannot be said that the cost of distribution is greater in one town than another, but it may, with some degree of plausibility and force, be argued that the difficulty of obtaining a supply for the metropolis, with its large population, causes the price to be higher than in localities where the supply far exceeds the demand. That the retail price is too high may be gathered from the fact that large dividends are paid by distributing companies to their shareholders, 10 per cent. not being considered a high figure, and in one London company the last dividend paid was 18 per cent. The distribution of milk is certainly more profitable than its production, but the farmers must be at this disadvantage till they can combine together in such numbers, and under such stringent rules, that they can have in our large towns depôts for distribution, and thus secure to themselves producers' and distributors' profits. Whatever has hitherto been attempted in this direction has generally failed from want of cohesion amongst those interested; consequently, to insure success, such companies or combinations must work under very stringent regulations, and have such management as is not under the control of any interested individual, who eventually works for himself and not for the many.

The long period of agricultural depression which has passed over this country has certainly brought together in closer sympathy the owner and occupier of land. The former sees that his tenant must, if he is to pay his way, be able to get a better price for his produce or a larger quantity of it. The subject of dairy farming is one that has excited much general attention, and its different ramifications have been studied wth care, to determine whether such improvement in quality or quantity of products cannot be made that this part of the farmer's business may pay a fair interest on capital. Thus the owner of land and the farmer have tried to solve such practical questions as the following :—

1. What breeds of cattle are best for the dairy farmer?

2. What description of food is best for the production of milk, due regard being paid to its quantity and quality?

3. What treatment should milk undergo to preserve its freshness for the longest time?

4. What is the best way of separating cream from milk?

(*a*) For consumption as cream.

(*b*) For making it into butter.

5. The causes of the variation in the quality of butter and cheese.

6. The regulations under which butter and cheese substitutes should be made and sold.

And in working on these different lines of research, the capitalist and the different agricultural societies have spared neither pains nor expense in studying the many complications underlying each of these questions, and elaborating certain general principles which must guide those engaged in the work in drawing sound and reliable conclusions from the numerous experiments and observations made. Of late years great progress has been effected on account of the different problems waiting solution being worked on in almost every agricultural country, and the results made known through the press. Thus new ground is constantly being opened up, and the spirit of inquiry is attracted to new lines of research, suggested by the failures or successes of experimenters as described in the literature of the day.

The consideration of what breeds of cattle are best for the dairy farmer is one that is wide and very far reaching. If the land and herbage were uniform, and the quantity of milk produced the only criterion of value, the matter could be easily settled, but the question is far more complicated. With variations of climate and soil, the marked difference in the composition of the milk itself, the value of the different breeds of cows to the butcher as well as to the farmer; these and many other cognate questions which have to be settled make the subject a most complicated one, and at best the matter cannot be decided on general but special grounds only, as what applies to one part of the country will not be successful in another. From experiments made by a friend, it was shown that in his extensive dairy no cow gave so much milk of his standard quality for the food consumed as the little Kerry; but, on account of its small size, no one would think of having a general dairy of Kerry cows, although they prove to be such generous milkers. The selection of well-bred stock exactly suited to the use of the dairy farmer is a work of the greatest importance, and one that cannot be

attained without years of labour. Well-bred cattle eat no more than the commonest kind, and the only difference is that more capital is required in the former case than the latter. Supposing that the capital is forthcoming, and the herd of well-bred animals purchased, it will soon be found that all are not equally productive. The successful dairy farmer steadily weeds out the failures, and tries to improve upon the good qualities of his most satisfactory specimens, for what was said eighty years ago by a famous stockbreeder is equally true now:—*"What has been produced by art must be continued by the same means, for the most improved breeds will soon return to a state of nature, or perhaps defects will arise which did not exist when the breed was in its natural state, unless the greatest attention is paid to the selection of the individuals which are to breed together;" and these lines have been so accurately followed since by some of our cattle breeders, that English pedigree stock has been sent to all parts of the world, and especially to Canada and the United States, where it would appear that before such importation the native breeds produced a maximum of bone and a minimum of beef. Of the different breeds of cattle used in this country for dairy purposes, it is evident that, from the general substitution of short for long horn cattle, the shorthorns are considered more suitable for the production of milk and flesh; and of this large class the Ayrshire breed is considered the best for hard grazing. As butter producers they do not rank so high, because the globules of fat in the milk being small they rise both slowly and imperfectly, and a considerable quantity of fat is thus left in the skim mik.

I am informed by Mr. Allander, the managing director of the Aylesbury Dairy Company, that for tying up he finds no cow so satisfactory as the red polled Suffolk and Norfolk cattle. Their special qualifications are that they rest contented in the byre, give milk of fair quantity and quality, and at the same time they keep themselves in good condition. No absolute rule can however be laid down as to what breed is the best, because local circumstances of climate and food, the demand for butter or milk, the keeping of cattle wholly or partly in sheds, are points to be taken into account in the selection of cattle. But whatever breed is most suitable, the cattle of the breed should be the best of their kind, well fed and housed, supplied with an unlimited quantity of pure water, and kept as comfortable and quiet as circumstances will permit.

Contentment and warmth are two great factors in the successful keeping of all animals, and this applies more strongly to cows in milk, whose flow of milk is diverted or suspended by very trivial causes. The American dairy farmers, who have made most rapid progress in dairy production, so well know the good arising from cattle contentment, that they try to secure men of well-known good temper and kindly disposition as cattle keepers and dairymen. It is well-known to those acquainted with dairy life that cows will not yield to a cruel, careless milker the same quantity of milk as they will to a gentle careful one. The quantity which is thus diminished is not compensated for by extra richness of quality, the loss is therefore absolute. A visit to a herd of cows at milking time will show that some cows are so frightened when the milker approaches that they cannot settle down during the whole milking operation, whilst others, with a cheery-faced milker, will chew their cud the whole time, and evidently enjoy themselves while being milked. That the temperament of cows greatly varies is well known, but after making full allowance for this variation, it is certain that the temper of the dairyman has a great effect on the general yield of milk.

The success in so few years of American and Canadian dairy farming proves conclusively the advantages which are derived from a judicious selection of stock and subsequent careful management of the cattle, but much of this success must be claimed for the agricultural departments of the two Governments. The continuous and systematic work done at the nation's expense has no equal in this country, and it is only necessary to look into the literature issued by these departments to convince ourselves that the progress of agriculture in these comparatively new countries must be rapid. The reports are most exhaustive, and the perfection of the machinery for obtaining information may be well illustrated by the fact that the cattle census for the United States, for 1888, was taken in January last, and the results issued on the 13th of February following. It must be admitted that individual enterprise has done much to improve our breed of cattle, and amongst the workers Sir John Bennett Lawes and Dr. Gilbert will stand in the foremost rank of

* Sir J. S. Sebright to the Right Honourable Sir Joseph Banks, 1809.

experimental chemists and agriculturists. But whilst giving the fullest praise to individual workers, and to typical landowners like Lord Vernon, it is only reasonable to look for some State recognition of the claims of agriculture for assistance. Continued commercial depression has compelled us to investigate its causes, and whilst over-production must be blamed as the chief, it is not the only cause of the depression. As a nation we are deficient in technical knowledge, and this deficiency is so marked, that technical training schools have come into great prominence, and under different names are receiving much assistance from the State. Why technical instruction should not be extended to agriculture is a question difficult to answer, and the anomaly has become so marked, that at last, as before stated, a Departmental Commission on agriculture and dairy schools has been appointed, which Commission has taken evidence, issued a report, and printed the notes of evidence. The suggestions made in the report are inadequate to secure fully the object aimed at, but as an instalment of a better and more comprehensive system of education, it is a very important step in the right direction.

The inquiry of the Commission embraced an investigation of the general state of agricultural education as at present existing in Great Britain, and this has been considered under the following heads:—

(*a.*) The teaching of the principles of agriculture as aided by the Science and Art Department.

(*b.*) The practice of dairy farming, including butter and cheese-making, breeding, rearing, and feeding of dairy stock.

(*c.*) The instruction now available for agricultural labourers, yeomen, and tenant farmers, and for the training of teachers.

(*d.*) The extent to which agricultural instruction is now afforded by universities, colleges, and schools, whether by means of existing endowments, Government grants, or private adventure.

The conclusions arrived at by the Commission are as follows:—

1. There is clear proof of great loss to the country through ignorance of the most effective modes of dairy practice and cognate agricultural operations.

2. That an efficient system for supplying this want, and for assisting our farmers to compete with foreign producers, who have the advantage of recently perfected systems of State-aided technical instruction, cannot be set on foot without the stimulus of similar State aid in this country.

3. That in view of the fact that very insufficient provision exists for agricultural teaching, and that virtually a new system has to be created, it would be unadvisable to embark on any large or complete scheme, but the endeavour should rather be to carry out cautiously the process of construction, to avoid unnecessary building, and to proceed on a well-matured system capable of future growth and extension.

4. That with the exception of a Central Normal School of Agriculture, provided and maintained by the State, and the utilisation of existing Middle-class Endowed Schools for practical teaching, all other agricultural schools now required should be originated by local effort, but stimulated and assisted by the Government.

5. That in dealing with this large question, the interests of labourers as well as farmers must be considered, and that to commence on prudent lines it would be necessary to select as centres the five produce districts into which England has been divided by the Agricultural Department, and two similar districts in Scotland.

6. That the district schools should be managed separately by a district committee, elected to represent all classes interested, and then to act in concert with the Royal or other important agricultural societies.

The recommendations of the Commission are:—

1. That in elementary schools increased facilities should be given for the study of the principles of agriculture, that encouragement to pupils should take the form of scholarships for boys and girls at the district dairy schools, and to teachers in the form of monetary, or other inducements, to improve their qualifications as teachers of agriculture.

2. That seven district dairy schools in Great Britain should at once be established, and that £500 a-year be paid by the State to each as an endowment, £50 a-year for scholarships, and a grant of £200 for equipment, with a special grant, where necessary, towards buildings, &c. That these district schools should be made partly self-supporting by the fees paid by ordinary students, and that rewards for progress should take the form of valuable exhibitions at the Central Normal School of Agriculture, to be established by the State, as a training college for teachers of dairy work, as well as for others not intending to be

teachers, but eventually extending the curriculum to the teaching of agriculture in all its branches.

Suggestions are made for establishing subsidiary middle-class endowed schools, for promoting higher agricultural education, for the establishment of travelling and other lecturers, for Government aid to be extended to minor dairy or agricultural schools, for an annual State grant in aid of original agricultural research, and for the State administration of agricultural schools. The Commission evidently understands that to write a report and make suggestions is a somewhat easy task, but to carry out these suggestions, even when backed by a willing Government, may prove difficult of execution. It is, therefore, recommended that an annual grant in aid, of about £15,000 a year, be obtained from the Government, that this sum should be placed at the disposal of the Agricultural Department of the Privy Council, to be applied generally on the lines recommended in the report.

The admission made in the last paragraph but one of the report is not satisfactory to the Government, or just to those engaged in agriculture. It is there shown that in the United States, Canada, and in nearly every State in Europe, agricultural teaching, of the nature suggested by the Commission, is afforded by the respective governments, that in the United Kingdom very large grants are annually made in favour of technical teaching of science and art applicable to various industries, that in Ireland our annual grant of about £2,700 is made to agricultural and dairy schools, in addition to providing for maintenance of buildings, but that in Great Britain agriculture derives, comparatively speaking, but small advantage from the Science and Art Department, and receives no annual grant similar to that which is given with such conspicuous advantage to the Glasnevin and Munster Schools.

If the Government acts on the lines recommended by the Commission, or establishes a Ministry of Agriculture, there can be no doubt that much good to agriculture will result from the adoption of either course. The many agricultural problems remaining unsolved will be attacked in a systematic comprehensive manner, and the experiment, conducted by different persons, for clearing up such points as the successful breeding and rearing of dairy cows, the cattle most suited for different agricultural districts, the relation between food and yield of products, will be diverted into one channel; and as the results will be published as State documents, there will be more done to benefit agriculture in a year than can now be accomplished by divided effort in ten. The absence of State aid in the past has caused the British agriculturist to get far behind in the race with his foreign competitor, and in the present condition of agriculture it will be difficult for him to regain any of the ground he has lost, unless he can be taught to get more produce than he does at present. Text-books on agriculture are generally expensive, are seldom written by practical men, and are out of the reach of the ordinary agriculturist; but if practical subjects can be taught under the eye of the farmer, as in Denmark, and he can see for himself the profit arising from new methods and processes, he will be tempted to work on new lines, improve his stock, alter his methods of farming, and prepare his produce for market in the most taking manner.

The relation existing between the quantity and quality of food given and the milk produced is one that the experiments made up to the present time, in this and other countries, have not been sufficiently numerous and prolonged to settle. That during the last twelve or fifteen years great progress has been made towards the solution of the problem is evident from the elaborate data recorded in the agricultural journals, and from the abandonment of a theory which was set up in a scientific manual published in 1874, and then believed in to a large extent. It was there stated that "Milk exhibits great constancy of composition; the effect of variations in the diet of the cow showing itself in the amount of the secretion rather than in its quality.......The milk of an animal has probably very much the same constancy of composition as the blood of the animal. It is well known that, by administering water to an animal, we are not able to dilute its blood to any considerable extent. Instead of telling on the blood, the water tells on the perspiration, or on the urine, so that from containing four or five per cent. of solids the urine may become so dilute as to contain only one per cent. of solids. The milk resembles the blood in this, and is in contrast with the urine, and by giving an animal an excess of water we do not dilute its milk but its urine."

The following table of results obtained from the examination of milk taken in the presence of specially skilled persons from cows milked

TABLE IV.—COMPOSITION OF THE MILK OF EACH OF FORTY-TWO COWS KEPT AT GLASNEVIN MODEL FARM, 1880. DETERMINED BY SIR C. CAMERON.

	100 parts of the milk contain										
	Morning's Milk.					Evening's Milk.					
	Water.	Solid Matters.	Solids, minus Fats.	Fats.	Ash.	Water.	Solid Matters.	Solids, minus Fats.	Fats.	Ash.	
1	88·00	12·00	8·90	3·10	0·65	86·98	13·02	9·02	4·00	0·66	1
2	88·30	11·70	8·81	2·89	0·61	87·30	12·70	9·20	3·50	0·62	2
3	87·20	12·80	8·90	3·90	0·67	85·89	14·11	9·01	5·10	0·70	3
4	87·52	12·48	8·98	3·50	0·70	86·31	13·69	9·19	4·50	0·70	4
5	85·58	14·42	10·23	4·19	0·80	84·78	15·22	9·68	5·54	0·78	5
6	88·10	11·90	9·02	2·88	0·61	87·40	12·60	8·60	4·00	0·64	6
7	86·70	13·30	9·40	3·90	0·78	86·58	13·42	9·48	3·94	0·78	7
8	88·15	11·85	8·65	3·20	0·68	87·40	12·60	8·60	4·00	0·74	8
9	87·27	12·73	9·24	3·49	0·72	88·47	11·53	8·84	2·69	0·65	9
10	86·20	13·80	9·10	4·70	0·72	84·92	15·08	10·08	5·00	0·75	10
11	87·54	12·46	8·96	3·50	0·72	86·00	14·00	10·19	3·81	0·70	11
12	87·30	12·70	8·60	4·10	0·65	88·10	11·90	8·20	3·70	0·63	12
13	86·20	13·80	9·60	4·20	0·75	86·22	13·78	9·58	4·20	0·72	13
14	87·80	12·20	8·90	3·30	0·75	85·90	14·10	10·00	4·10	0·63	14
15	87·70	12·30	8·65	3·65	0·65	87·60	12·40	8·27	4·13	0·65	15
16	85·70	14·30	9·70	4·60	0·80	84·67	15·33	9·73	5·60	0·78	16
17	84·50	15·50	11·10	4·40	0·78	84·50	15·50	11·30	4·20	0·78	17
18	86·68	13·32	9·62	3·70	0·78	86·60	13·40	9·70	3·70	0·77	18
19	86·92	13·08	9·18	3·90	0·68	85·91	14·09	9·19	4·90	0·69	19
20	84·92	15·08	11·78	3·30	0·69	85·05	14·95	9·93	5·02	0·65	20
21	85·75	14·25	10·75	3·50	0·75	85·70	14·30	10·78	3·52	0·80	21
22	86·68	13·32	8·62	4·70	0·73	87·52	12·48	8·48	4·00	0·74	22
23	86·12	13·88	9·28	4·60	0·70	85·49	14·51	9·51	5·00	0·68	23
24	88·34	11·66	8·68	2·98	0·61	86·00	14·00	10·02	3·98	0·68	24
25	88·52	11·48	8·50	2·98	0·62	85·74	14·26	10·24	4·02	0·72	25
26	87·10	12·90	9·40	3·50	0·70	85·68	14·32	10·42	3·90	0·68	26
27	86·94	13·06	9·66	3·40	0·75	87·34	12·66	9·00	3·66	0·70	27
28	86·17	13·83	8·78	5·05	0·72	87·00	13·00	8·75	4·25	0·65	28
29	85·20	14·80	10·80	4·00	0·77	85·90	14·10	9·90	4·20	0·77	29
30	87·20	12·80	8·80	4·00	0·69	87·40	12·60	9·00	3·60	0·68	30
31	87·10	12·90	9·21	3·69	0·67	87·71	12·29	8·23	4·06	0·68	31
32	87·20	12·80	8·80	4·00	0·66	87·00	13·00	9·30	3·70	0·67	32
33	87·68	12·32	9·12	3·20	0·69	87·18	12·82	9·16	3·66	0·70	33
34	85·74	14·26	10·14	4·12	0·75	87·34	12·66	9·06	3·60	0·80	34
35	84·80	15·20	10·00	5·20	0·78	84·05	15·95	10·69	5·26	0·81	35
36	85·70	14·30	10·64	3·66	0·80	83·20	16·80	10·50	6·30	0·68	36
37	85·09	14·91	9·51	5·40	0·71	84·85	15·15	9·73	5·42	0·68	37
38	88·56	11·44	8·25	3·19	0·63	87·20	12·80	9·30	3·50	0·70	38
39	86·79	13·21	9·53	3·68	0·78	86·38	13·62	9·52	4·10	0·79	39
40	87·30	12·70	8·95	3·75	0·70	86·54	13·46	9·56	3·90	0·73	40
41	87·40	12·60	9·10	3·50	0·78	85·20	14·80	10·77	4·03	0·69	41
42	85·90	14·10	10·15	3·95	0·72	85·80	14·20	10·21	3·99	0·72	42
Averages	86·80	13·20	9·38	3·82	0·71	86·26	13·74	9·52	4·22	0·708	42
Mixed whole milk, 42 cows	86·10	13·90	9·70	4·20	0·73	85·54	14·46	9·82	4·64	0·727	
Strippings of 42 cows	84·00	16·00	9·58	6·42	0·80	83·45	16·65	9·54	7·11	0·797	

NOTE.—*Difference between the Quantity yielded Morning and Evening.* — In every instance the quantity of milk yielded in the morning exceeded the proportion furnished in the evening. In two instances the morning's supply was three times more abundant, and, in very many cases, twice as plentiful. About eight hours intervened between the milkings.

Superiority of the Evening's Milk.—Thirty out of the forty-two cows gave richer milk in the evening than in the morning, and eleven cows gave richer milk in the morning than in the evening, whilst the remaining cow's milk was equally good at both milkings. The average amount of solids in the morning's milk was 13·20, and in the evening's 13·74, a difference of ·54 per cent. The increase in the amount of solid matters in the evening's milk was due chiefly to the larger amount of fats contained in the latter. The amount was 4·22, or 0·4 per cent. over the proportion (3·82 per cent.) found in the morning's milk. In the case of the mixed milk of forty-two cows, that yielded in the evening was richer by ·56 per cent. of solid matters, including 0·44 per cent. of fats.

out completely, will show that there was no actual foundation for such a theory, and careful observers, like the late Dr. Voelcker, had also proved that the milk given by ordinarily fed dairy cows varied greatly in composition.

The feeding experiments before referred to as not being yet completed will throw further light on this interesting subject, but a gentleman who is deeply engaged in the work tells me that there is "Milk and milk—Vin Ordinaire and Chateau Lafite," and that "Food has everything to do with both quantity and quality." It would appear, however, from a series of experiments instituted by Lord Vernon at Sudbury, and carried out under the direction of a committee of the British Dairy Farmers' Association, that this variation in the quality of the milk can be considerably modified in the case of cows having what may be termed a perfect supply of food—that is, the maximum quantity they can assimilate. Whilst each cow's milk varies more or less from the other, it would appear from the results of experiments made on 30 cows—and which have been confirmed in the United States—that when the maximum quantity and quality are reached by giving the perfect food, any addition to the food after the maximum assimilation point is reached neither adds to quantity or quality of milk, but that the food is wasted as food, and only adds to the richness of the farmyard manure. The results obtained are of very great value to the agriculturist; but it will be apparent that such experiments can only be carried on with stall-fed cattle, and cannot apply to the ordinary dairy cow, which lives mainly on grass. The food of this large class must from day to day vary in quantity and quality; and it is only fair to remark that they very seldom get a perfect supply of food, and therefore do not yield their maximum quantity or quality of milk. Here we must look for the improvement to be worked in the dairy farmer's condition. So many overlook the fact that

TABLE V.—COMPOSITION OF DAIRY SAMPLES OF MILK.

Determined in our Laboratory.

Specific Gravity.	Per-centage by Weight of Solids. Non-fatty.	Fat.	Total.	Ash.	Per-centage by volume of cream.
1031·70	9·55	5·14	14·69	·63	16·0
1031·61	9·57	4·83	14·40	·77	14·0
1030·73	9·10	4·62	13·72	·65	16·0
1033·05	9·28	3·99	13·27	·73	8·0
1031·51	8·70	3·21	11·91	·72	5·5
1029·88	9·05	4·03	13·08	·72	10·0
1031·05	9·23	4·40	13·63	·74	13·0
1029·76	8·50	3·65	12·15	·74	9·5
1029·93	8·62	3·66	12·28	·69	9·0
1029·46	8 70	4·37	13·07	·70	7·5
1030·91	8·88	3·38	12·26	·74	7·0
1028·91	8·80	3·28	12·08	·65	—
1030·72	8·82	2·95	11·77	·78	6·0
1031·35	9·00	3·66	12·66	·67	6·0
1029·15	8 50	3·37	11·87	·65	7·0
1030·70	9·91	3·58	13·49	·76	10·0
1031·00	9·60	3·62	13·22	·72	12·0
1031·60	9·51	4·70	14·21	·78	13·0
1031·60	9·30	4·58	13·88	·75	—
1031·00	9·14	5·10	14·24	·75	—
1030·40	8 82	4·42	13 24	·74	—
1031·40	9·16	4·43	13·59	·78	—
1029·80	8·80	4·98	13·78	·67	—
1029·70	8·81	4·99	13·80	·69	—
Average	9·01	4·12	13·22	·72	—

Individual Samples of 240 Cows' Milk, taken in presence of a responsible person.

Maximum......	11·27	6·87	—	·87
Minimum	8·00	1·92	—	·62
Average	9·00	3·83	12·83	·71

TABLE VI.—CONSTITUENTS OF THE ASH OF COWS' MILK.

Per-centage of			Average milk of 29 cows.	Average milk of several cows	Average milk of several cows.	Milk of short-horn 5 years old.
Total Ash			0·73	0·72	0·78	0·71
Potash	estimated as	K_2O	17·24	19·53	19·78	19·83
Soda	,, ,,	Na_2O	4·29	3·30	3·67	3·19
Lime	,, ,,	CaO	24·53	24·48	24·78	25·98
Magnesia	,, ,,	MgO	2·89	4·76	4·35	3·68
Phosphoric Anhydride	,, ,,	P_2O_5	35·67	32·49	32·07	32·67
Sulphuric ,,	,, ,,	SO_3	2·65	0·92	0·69	1·62
Chlorine ,,	,, ,,	Cl_2	12·73	14·52	14·66	13·03
		Total	100·00	100·00	100·00	100·00

TABLE VII.—CONSTITUENTS OF COWS' MILK.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity	1031·56	1031·56	1031·00	1032·50	1029·80
Total solids	11·47	11·09	11·98	12·79	15·89
Non-fatty solids	8·71	8·66	8·65	9·03	9·10
Fatty percentage	2·76	2·43	3·33	3·76	6·79
Casein	3·05	2·96	3·18	3·50	3·31
Sugar	4·91	4·96	4·75	4·75	5·07
Ash	0·75	0·74	0·72	0·78	0·72
Water	88·53	88·91	88·02	87·21	84·11
Total	100·00	100·00	100·00	100·00	100·00

whatever milk or beef is produced, it is obtained from the food the cow eats. Long journeys to pasture, the difficulty of getting food in a poor pasture without great exertion, bad housing, exposure to cold, cruel treatment—all these privations and punishments have an effect on the milk supply. The dairy cow must first of all live before she can produce milk from the food she eats, and a very large proportion of this food goes to keep the cow in fair condition before any milk can be produced from it. Consequently, all profit that comes from a dairy cow must come from that food she eats over and above what is necessary to sustain life. It has been said, with great truth, that a dairy cow is simply a machine for the production of milk; that if the cow is pinched of food, she will not yield a profitable quantity of milk; that some cows consume a great deal of food to waste; that it is advisable to carefully test the milk-producing capacity of a suspected cow by comparing the weight of the food she eats with the milk she yields; and thus, by observation and selection, eventually obtain a first-class herd of dairy cows.

Milk is a natural product intended to be the sole food of certain classes of animals until they are able to assimulate other descriptions of food. How milk is formed in the animal is a problem which has not yet been satisfactorily solved, but from numerous experiments and observations made, opinions seem to be divided into two classes, viz., that milk is formed by the filtration of its constituents from the blood through the mammal gland, and their conversion into milk by this process; and, secondly, that milk is formed in the gland itself by the decomposition of its own cells. Much has been said and written in favour of both views, but physiologists at present are disposed to believe that a combination of the two views can alone satisfy the present state of scientific knowledge on the subject of milk secretion.

The milk in the udder is not of uniform composition. The fatty matter is present in larger quantity at the top of the milk, and consequently the milk first pressed out of the udder is very poor in fat. From experiments determined to clear up this point, it may be stated roughly that if the meal of milk be divided into four equal parts, the first portion milked will contain 10 per cent. of the fat, the second portion 20 per cent., the third portion 30 per cent., and the fourth portion 40 per cent. This partial diffusion of the fat through the milk in the udder is so well known that it is a common practice with unscrupulous dairymen to keep back the last milk or strippings, and employ it for raising cream, or for other

special use. In such cases the bulk of the milk sold will be of very poor quality, as it has been deprived of a portion of its fat as effectually as if a quantity of skimmed milk had been added to it.

The appearance of milk is so well known that no general description is needed, but when closely examined it is found by chemical tests to be slightly alkaline, or neutral when first drawn from the animal, but by keeping it developes acid, which development is either accelerated or retarded by certain circumstances. Its weight, as compared with water, is as 10·3 to 10·0, but this comparison is not quite constant, the specific gravity being influenced by different foods and other causes. The extent of this variation can be observed in the table already given. Under the microscope milk is seen to consist of a clear liquid, having throughout it globules in suspension of different sizes. These globules are of a fatty nature, and when the milk is allowed to rest, they rise by their lighter gravity to the surface, and form the cream of commerce. The lower stratum becomes clearer by this separation, and after a time further changes take place in its physical appearance. It becomes slightly acid to the taste, and on further exposure to the air coagulation takes place, the lower stratum being thus divided into a white deposit and a clear liquid. It has been observed that this coagulation can be hastened by the addition of a small quantity of sour milk and by elevation of temperature, as in summer weather. It is also well known that milk, when slightly acid, and apparently homogeneous, will, when boiled, curdle. The study of these different phenomena has enabled the observer to find out the causes of these changes, and it is owing to this knowledge that the dairy farmer of the present day is able to preserve his milk for a very much longer period than formerly, and to reduce his dairy operations to such a system as enables him to secure uniformity of results, and consequent control in his dairy management.

Before passing on in detail to the different processes in force to secure to the consumer good milk and its products, it seems necessary to say a few words on the chemical composition of milk from the physiologist's point of view, and to show that milk is a true typical food, made up of certain essential constituents necessary for sustaining life and building up the body. We have seen that milk, on standing, forms into two layers, the upper one consisting principally of fatty matter. The lower layer, separating as it does by further standing, is not homogeneous, and is composed of water, matter containing nitrogen, a substance made up of carbon and hydrogen (lactine), and certain mineral salts.

However much these substances may differ in quantity in milk taken from different classes of animals, the same substances have been found in all, and the deduction was naturally drawn from this fact that they were all essentially necessary for the growth and nutrition of animals. But a question arose whether it would not be possible to combine these substances, when taken from different sources, in such a way that the artificial product could be substituted for the natural food. It has been found from experiment that no such substitution can be made without injury, and however much better some artificial substances are than others, none can equal the natural product taken from nature's storehouse, and of which there is generally a full supply. Experiments have also been carried out, to prove whether all were necessary in combination to accomplish the purpose for which milk is naturally supplied. It was at one time thought that nitrogenous compounds ought to be able to sustain life; animals were therefore fed solely on a nitrogenous diet, with the result that they all died. Food free from fat has been tried with a like result, and, without enumerating details, it has been verified by many experimenters, working in different ways, that milk is perfect in its composition for the purpose it is intended to serve, and that no artificial production can be properly substituted for it. The flesh-forming and heat-giving powers of milk are perfect, and it is interesting to note that these proportions vary in the milk of certain classes of animals to suit their actual requirements. In fact, as milk is formed for the special purpose of being the sole nourishment during the first period of infantile life, it not only contains the principles absolutely necessary for the growth and maintenance of the body, but these principles are in such a form as to be capable of being easily assimilated by the weak digestive powers of the infant. Human milk varies greatly from that of the cow, and it may be of interest to put the composition of different descriptions of milk side by side, to see the nature and extent of their variations.

It will be observed that the casein is lower and the sugar higher in human milk than in that of the cow, and the mineral matter is not more than half as much in human milk as in

cow's milk. The physical properties of the casein found in these milks are not identical, and evidently some of them, especially that of the mare and human milk, differ greatly, for on the addition of acetic acid the casein separates slightly only, not forming a solid mass, as in cow's milk. It has been inferred that this peculiar property points out that such milk is more easy of assimilation than milk whose casein is more readily separated by the addition of acid.

TABLE VIII.—Analyses of Different Kinds of Milk.

Constituents.	Woman, age 18.	Woman, age 33.	Mare.	Goat.	Ewe.
Specific gravity	1034·50	1033·03	1036 12	1032·70	1039·30
Fat	3·20	2·99	1·76	5 80	11·28
Casein, albumen, &c.	2·39	2·51	3·58	4·20	8 83
Sugar	6 83	6·51	5·87	4·94	3·58
Ash	·29	·30	·39	1·00	1·09
Water	87·29	87 69	88·40	84·05	75·22
Total	100·00	100·00	100·00	100·00	100 00

TABLE IX.—Analyses of Condensed Milks.

Desciption.	Percentage of				
	Water.	Fat.	Cane & Milk Sugar.	Casein.	Ash.
Swiss	26·70	9 76	51·02	10·20	2·32
English	27 07	8·30	50·79	11·84	2·00
Pure Swiss Milk	62·20	10·21	14·89	10·29	2·41
Condensed	61·40	11 37	13·37	11·48	2·38
Pure Condensed	62·79	10·26	15·86	9·00	2·09
Alpine Milk	62·35	11·15	13·14	11·29	2·07

The treatment milk must undergo to preserve its freshness for the longest time is of vast importance to producer and consumer. The delivery of milk in the immediate neighbourhood where it is produced is a matter of no great difficulty, but to keep it sweet in trying weather, when removed to a distance, is the great concern of our milk producers. On this subject we have much to learn from American dairymen. With the very rapid growth of towns, local sanitary laws do not permit the housing of cattle in them, consequently the milk supply is drawn from the country, and being done on a large scale, capital and skill are combined to secure all the profit possible to those engaged in the trade. The general rule followed is to cool the milk immediately it is taken from the cow, and whatever method may be adopted the aim is the same, viz., to reduce the temperature of the milk to about 50° Fahr. or less within an hour. In England a refrigerator, through which a stream of cold water is constantly flowing, is attached to the vessel into which the milk is first collected, and according to the temperature of the water used, and the strength of the flow of milk over the refrigerator, the milk is more or less cooled. The cooled milk should be carefully protected from a rise in temperature till it is sold to the consumer, and to insure this protection the cans are in summer frequently covered with a wet flannel case, or other non-conducting material to keep the milk cool.

In hot weather it is difficult to preserve the milk sound and fresh for any length of time, and frequently it has to be used for making butter in consequence. Experiments have been made on a large scale in America to prove whether other processes than the general one of cooling might not be adopted. These experiments have taken the form of straining the milk into cans immediately after it is milked, and hermetically sealing the cans so filled at a temperature above 90° Fahr. Other manipulation connected with the operation is kept a secret, but the fact remains that milk so prepared has kept well quite as long as that subjected to the cooling process of treatment. There are, however, many difficulties in the way of hermetically sealing milk at the ordinary dairy, and the almost universal process of cooling affords distinct proof that it is preferable. But if any other proof were needed, we can obtain it without difficulty, and from the following unerring source.

The "turning" of milk, which is the cause of such serious loss to the producer, has now been well investigated, and its origin traced. The occurrence is so natural and common that for a long time it was thought that milk contained within itself, even when drawn from the cow, a ferment or other substance which, acting on the milk, compelled it to turn, and to break up eventually into curds and whey. It was found, however, that if the milk in its fresh state were boiled, its keeping properties were thereby greatly improved, and its resistance to turning very much prolonged. The question to settle was whether the fermenting or decomposing substance was natural to the

milk, or got into it after it was taken from the udder; and the fact that milk was preserved by boiling led Lister and others to make a series of experiments which eventually settled the question. They knew that living organisms of different kinds were constantly floating in the air, and possessing this knowledge, they transferred milk from the cow, without exposure to the air, into carefully prepared vessels which they thought quite free from air germs or organisms. The milk in some of the vessels kept sweet for an unlimited time, whilst other samples decomposed. The decomposed samples contained the same minute organism which was found in sour milk, and the only conclusion that could be reasonably drawn from the experiments was that the precautions to exclude foreign organisms were not satisfactory, because some samples of the same milk kept sound, and others became sour. Greater precautions against contamination were made in future experiments, and at last milk could be so prepared as to be kept for any period without decomposition.

The next question which arose was whether this undecomposed milk had changed its properties by the treatment it had undergone, and to test this point a small quantity of sour milk was added to several of the undecomposed samples, with the result that each sample so treated became sour. Further investigation was made to isolate this peculiar organism always found in sour milk, to be quite certain that it was the cause of the mischief. This was done, and it was thus proved beyond doubt that the organism was the cause, and as the sourness was found to be due to the conversion of the sugar naturally present in milk into lactic acid, this organism was called the lactic ferment. The study of its life history throws much light on the causes of the souring of milk. It cannot be active as a ferment except where there is free oxygen, and consequently, when milk is exposed to the air, the oxygen necessary for its development is thus obtained. It has also been proved by experiment that the activity of the lactic ferment is not the same at all temperatures. Thus, at a temperature below 50° F. no development can be observed, but at 60° F. the development is more active, and increases in activity till the temperature of the blood (98° F.) is reached, becoming quiescent at about 110° F. The ferment is not killed at the temperature of boiling water, and some minutes' continuous boiling is necessary to destroy it. With these facts before us, it is easy to understand why the boiling of milk acts as a preservative, and the rapid cooling of milk when first taken from the cow, and keeping its temperature below 50° F., should also improve its keeping qualities. In each of these instances the effect of the heating and cooling has been observed before the cause was known, and in this, as in many other well-attested cases of a similar kind, science is only the handmaid to reconcile effect with cause. From what has been adduced, it will be evident that without cleanliness it is impossible to profitably engage in the milk industry, and the possession of this knowledge has done much to make our town distribution of milk as satisfactory as it is to-day, because perfect cleanliness and the traders' profits go hand-in-hand. Dirt cannot be allowed to exist in a dairy on account of the loss it causes, and the only vessels where carelessness and indifference continue to linger seem to be the infants' feeding bottles, which in many cases are neither clean nor sweet. The havoc worked in this way can be read in the faces of those children who have to use these dirty bottles, and emaciated, unhealthy bodies bear testimony to the infant mortality arising from this poisonous source.

It has been observed that the milk producers and distributors have, to conserve their own interest, been compelled to check the quality of their milk supply, and what has been accomplished in this direction may prove of general interest. Very little was done to protect the public from food adulteration before 1860, but even the first general Act passed in that year made the appointment of analysts permissive only, and the obtaining of samples for analysis was left to private purchasers. In 1872 another Act was passed, extending the right of appointing analysts to those boroughs which had their own distinctive police establishments; the appointment of analysts was, however, still optional. Local officials were, however, to purchase the samples for analysis, and private persons could secure an analysis on the payment of a small fee. The working of the Act proved arbitrary and unsatisfactory, and a Select Committee of the House of Commons was appointed to investigate and report. The recommendations of this Committee were that the Acts of 1860 and 1872 should be repealed, and the substitution of an extended and compulsory Act in place of them. The chief changes suggested, and eventually made legal, were that the fraudulent abstraction of an important

ingredient from any commodity embraced by the Act should be a punishable offence; that tea should be examined before being cleared for consumption; that better regulations be put in force for securing the appointment of efficient analysts and for the purchase of samples; and that provision be made for securing an independent official analysis in case of dispute.

The Sale of Food and Drugs Act, of 1875, and its Amendment Act of 1879, form our general adulteration code. The gist of the Act is expressed in the sixth section of the first Act in these words, "No person shall sell to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance, and quality of the article demanded by such purchaser." The exact meaning of the expression "prejudice of the purchaser," has been the subject of more than one legal decision, but it is now fairly well established that it does not apply to the sale of articles of low quality, but genuine, and this view is entertained by the Local Government Board, who have the general supervision of the working of the Acts in question. It will be apparent, from the great variation in the composition of natural healthy milk, that the construction of Clause 6, before referred to, must of necessity make milk analysis the battle-ground of the Adulteration Act. This has proved to be the case, and especially so since it was assumed that milk was constant in composition, and that if it were variable in strength chemical analysis would fail to detect the presence of added water. If this assumption even approached accuracy, milk analysis would be most simple; but not being correct, the results obtained from the examination of a sample of poor quality milk have all to be carefully considered before arriving at a definite conclusion, and even then the conclusion may not be accurate.

But, fortunately for commercial purposes, it is not necessary to work with a chemist's accuracy. The farmer or milk dealer has to decide whether the milk he obtains, either from his cows or in the way of trade, is of proper value, and if not, he either gets rid of the cow or of the dealer who supplies him with poor milk. He therefore tries comparative tests, and the first which suggests itself is based on the separation of the cream from the milk on standing. Such a method of determination is in general use, and the instrument is called a creamometer or cream measurer. Its accuracy is impaired by the fact that there is no definite relation between the per-centage of fat and the quantity of cream measured; that the rising of the cream is accelerated, retarded, or stopped by certain circumstances; and that there is always some cream left in the milk which cannot be so separated. It is not, therefore, a reliable instrument.

The specific gravity of milk has also been considered a good criterion of value, and to make this determination hydrometers have been prepared, which are sold under the name of lactometers. The results obtained are very fallacious, because butter fat, which is lighter than water, if present in considerable quantity, will lower the specific gravity in the same way as the addition of water would do. A combination of the results obtained by the lactometer and creamometer is best, but even their results, when taken together, are imperfect, and very unreliable in special cases. In such cases the appearance and condition of the sample under examination will, to a practised eye, enable him to interpret abnormal results with fair accuracy, and consequently these two instruments are generally relied on in ordinary dairy work. Attempts have been made to work out an optical test which should be dependent on the degree of opacity of the milk, but as it is well known that the colour of the milk, the size of the globules of fat, and the thickness of the walls of these fat globules vary, no colour test yet devised has even approached accuracy.

Farmers and dairymen having cream separators have other ways open to them of determining the quality of their milk, but as separating machines have not been described, but will be so in the next lecture, references to the processes of fat separation dependent on them may be conveniently deferred.

Ordinary milk analysis consists in the determination of the original gravity of the milk, the quantity of solids it contains, the proportion of fat present, and the amount of mineral matter left on ignition. There is considerable difficulty in separating the fat absolutely, and this difficulty has led to much of the disagreement which has arisen on the subject of milk analysis. It is apparent that, as the total solids of milk are divided into "fat" and "solids not fat," if the whole of the fat is not removed the residue of "solids not fat" will be too high. The solvent used for separating the fatty matter is ether or light petroleum spirit. Each of these liquids is a perfect solvent if brought into direct contact with fat, but in milk the solid matter to be operated on is so

tough and compact that it locks up the fat, and it is, therefore, necessary to get it, in some way or other, into a porous condition, that the spirit used may dissolve out every particle of fatty matter. The mode of obtaining this porous condition is practically the groundwork of the different systems of milk analysis. The primary and most obvious method was to reduce the solids to powder by manual labour. With this intention ether or petroleum spirit is poured on to the partially dried mass of milk solids, and by constant grinding with a glass rod the mass becomes pulverised. By constant application of further quantities of the solvent, and repeated grinding, the whole of the fat is at length removed, and the solid matter left behind can be dried and weighed, which is the "solids not fat." The spirit having the fat in solution is slowly evaporated, and at the last the fat becomes dry and is weighed. The two weights should together make up the "total solids." Chemists have tried to get over the tediousness of the process described by putting into the milk weighed quantities of gypsum or pumice stone, which has the property of dividing the particles of milk, and allowing the solvent to take out the fat. In either case the "solids not fat" cannot be weighed, and the check on the working is not therefore perfect. The operations have the advantage of reducing the mechanical labour of the analysis, and the analyst is able to proceed with several analyses at the same time. This saving of time is of considerable importance in the analyst's work, for the fees allowed under the Adulteration Acts are so small that they are barely remunerative, and he has consequently to study the quickest and cheapest, though perhaps not the most exact, methods of analysis for the examination of ordinary samples. A coil of unglazed paper has recently been used for absorbing the milk, and leaving it in a divided state for the action of the fat solvent, but there are objections to its use which are too technical to be exhaustively treated in a popular manner. And here it need only be said that the "solids not fat" cannot be weighed when this process is employed.

Without a knowledge of the history of the milk submitted for analysis, the analyst is in certain cases, as before stated, unable to say whether the milk has been adulterated with water or not; but in spite of all the difficulties surrounding milk analysis through its variableness of composition, the Food and Drugs' Act has worked very well. It has conferred great benefits on the consumer; it has indirectly been the means of educating the farmer as to the regulation of the quantity and quality of his milk supply, and directly taught him that food, warmth, and cleanliness have a direct influence on the quantity and quality of the milk secretion.

The great changes which have taken place in our milk supply during the last twenty years have been thus hurriedly sketched, and the improvements to the consumer in the regularity and quality of this supply through trade concentration, the incidence of the Food and Drugs Act, and cleanliness, are manifest.

In the next two lectures it will be shown that far greater changes have taken place with respect to the supply of butter and cheese, the area of supply being greatly enlarged. The quality also has improved, and due attention has been paid to the consumer's requirements as to the form of making up and packing the butter and cheese, which facts will be illustrated by specimens of the different kinds of butter and cheese now met with in commerce.

Miscellaneous.

POTTERY IN LIMOGES.

China is selling at a lower rate now, says Consul Guffin, of Limoges, than it has done for many years past, the reason being that the price of labour has decreased 10 per cent. in the last five years, machinery has in many instances replaced hand labour, and the saucer maker has entirely disappeared since the strike in 1883. The rates of interest and insurance greatly favour the manufacturer. The price of coal and wood is lower than in previous years, the former costing from 25 frs. to 35 frs. per ton delivered at the factory, and the price of the latter is from 10 frs. to 12 frs. per stére. The year 1887 shows a decided decrease in the production of china; there was a steady decline from 1882 to 1886. In the year 1887 there was employed in the manufacture of china at Limoges 1,621 coal furnaces, as compared with 1,528 in the preceding year, and 324 wood furnaces against 323 in 1886. Some manufacturers burn wood although it is more expensive than coal, the reason of this being that they think the sulphurous fumes from the coal injure the colour of the china. Few colours have yet been discovered that will resist the gases of coal, so wood is used exclusively to heat the *moufles*, the furnace where the paintings are fired. Limoges china is in demand all over the world, but by far the largest share goes to the United States. The production last year amounted to over 8,000,000 frs., nearly half of which was exported to the United States.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

"OWEN JONES" PRIZES.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon trust to expend the interest thereon in prizes to "Students of the School of Art who, in annual competition, produce the best design for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates for the present year:—

1. James J. F. King, School of Art, Glasgow.—Design for Persian carpet.
2. Herbert Cole, School of Art, Cavendish-street, Manchester.—Design for carpets.
3. Andrew Richmond, School of Art, Glasgow.—Design for printed hanging.
4. Emily Batters, School of Art, Hertford.—Design for tiles.
5. Samuel H. Moss, School of Art, Macclesfield.—Design for tiles.
6. George Pettitt, School of Art, Cavendish-street, Manchester.—Design for printed hangings.

The next award will be made in 1889, when six prizes will be offered for competition.

Proceedings of the Society.

CANTOR LECTURES.

OUR MILK, BUTTER, AND CHEESE SUPPLY.

By Richard Bannister, F.I.C., F.C.S.

Lecture II.—Delivered April 16, 1888.

Our Butter Supply.

It has been shown that the tendency of the last twenty years' dairy farming has been to send the milk produced in this country to our own towns for consumption as milk; consequently the manufacture of butter and cheese in the United Kingdom has greatly diminished, and we are more than ever dependent on foreign countries for the supply of these two necessaries of life. In districts where railway facilities do not encourage the town milk trade, the milk produced is retained for making butter and cheese, but even in outlying districts such as these the relative prices of butter and cheese tempt the farmer to make butter when cheese has been very cheap, or *vice versâ*, and this change of system has naturally an effect on prices. There is, therefore, an element of uncertainty in dairying operations at the present time; and what with keen competition, the knowledge the farmer has of the quantity of butter and cheese he can obtain from his milk, and the cost of manufacture, there are factors to be considered in dairy operations which, not many years ago, need not have been considered at all. The subject of this lecture, "Our Butter Supply," is one which has to be considered from a variety of standpoints. Thus, for instance, some countries, such as Ireland, Denmark, France, Sweden, and Norway, are not cheese producers to any great extent, whilst others, such as Holland, the United States, and Canada, are large cheese and butter producers. Again, certain countries which are large butter producers cannot, from their distance from us or from other causes, send to this country absolutely fresh butter, whilst others, either from concentration of business, or from their favourable geographical position, supply large quantities of fresh butter, and only salt down the common and inferior kinds for winter consumption, or for cooking purposes. But, using

as we do large quantities of fresh and salt butters, it follows that here there is a market for foreign butter, and the quantity required is large enough to tempt foreign producers to work for our consumption, and every year the consumption of foreign butter is on the increase. Tables X. and XI. (p. 983, 984), obtained from official sources, will show that the value of the butter and butter substitutes imported now exceeds ten millions per annum. The quality of much of the foreign-made fresh butter is superior to the home made, and is far more uniform in quality. Wholesale merchants have long ago appreciated this difference, and have preferred the butter of uniform quality, irrespective of its origin. Philanthropy and patriotism cannot enter into commerce, and, therefore, it is necessary that home produce must, in every respect, equal imported butter before it can command the same price. There is no doubt that much of the superiority of the best brands of foreign butter is due to the knowledge brought to bear on its production, and the State aid given in almost every country except our own has done much to educate the people till they know the best methods of manufacture. In this country the dairy farmer has generally worked alone, and taken the butter made to the nearest local market, having to receive for it the current price of the day. A glance at the butter so made will indicate why it can only have a local reputation, for no two dairies produce exactly the same article, and for general trade the quality is too irregular and low. The incidence of this state of things has driven dairy farmers, in certain districts, to combine together in different ways to produce butter which shall be more uniform in quality; and though the efforts made in this direction have been only partially successful, yet they have had an effect in improving the quality of home-made butter, and have accustomed the small farmer to study uniformity of quality more than was ever done before. In Ireland, as before stated, a small Government grant is made to the two dairy schools of Glasnevin and Munster, and these two schools have already had an appreciable effect on the Irish dairy industry by securing greater uniformity in quality, and stimulating wholesome emulation among the farmers to work for more *best* butter and less *seconds* than they did.

The difficulties which have to be faced by our dairy farmers are not insurmountable, they being in the same position to-day as their continental competitors were twenty years ago, but with this difference, however, that their goods have to a great extent been superseded by those of foreign manufacture. It has been proved in actual practice that it is impossible for individual effort, except where large capital can be employed, to successfully compete in butter and cheese making. In such circumstances uniformity cannot be secured, and this absence of uniformity enables the dealer to buy such butter or cheese far below its real value, and thus deprive the producer of a part of his profit. In Ireland, which is a typical grazing country, the principle of co-operative combination has assumed curious phases, and these will be indicated to show what has been done in other countries in the same direction. The simplest plan was to let cows to dairymen for the season. The cows were expected to give at least two gallons of milk a day, and if they did not give this quantity they were rejected. Where this could not be carried out, another plan was for those having a cow or two to combine together to churn the cream produced, the churning taking place alternately in the houses of those who had joined the circle. The firkin of butter thus produced was sold, and the proceeds divided according to certain rules laid down at the time the combination was formed. This plan of co-operation has been so successful that during the last year or two it has been tried on a large scale. Creamery companies have been started in districts in the south of Ireland, the principle on which they work being that a proper record is kept of the cream sent in by the different contributors, the butter made on the most approved system by an experienced dairymaid, and when sold the expenses of making deducted, and the proceeds equitably divided. It is evident that if the cream sent in were mixed together before churning, much care and discernment would have to be exercised as to the quality and condition of the cream received, because if the cream is thin the contributor gets more than his share of the profits, and if out of condition the flavour of all the butter would be deteriorated, and the price lowered accordingly. By the creamery method of working, the skim milk, which is a very valuable bye-product in butter manufacture, is left in the hands of the dairy farmer to use for pig-feeding, or in any other way most profitable to himself. On account of the difficulty experienced in getting the farmers to adhere to the general regulations laid down for the working of the "creameries," it has been found necessary to keep each farmer's cream distinct, and churn it alone. The butter

TABLE X.—IMPORTS OF BUTTER.

Year.	From United States.		From Other Countries.		Total Quantity.	Total Value.
	Cwts.	Value.	Cwts.	Value.		
		£		£	Cwts.	£
1859* ..	3,570	12,659	422,093	2,067,484	425,663	2,080,143
1860....	82,015	347,459	758,097	3,730,558	840,112	4,078,017
1861....	180,560	815,861	812,212	4,086,533	992,772	4,902,394
1862....	274,340	1,179,010	763,031	3,744,090	1,037,371	4,923,100
1863....	173,351	701,127	813,357	3,836,030	986,708	4,537,157
1864....	142,672	720,024	911,945	4,932,680	1,054,617	5,652,704
1865....	83,216	437,703	1,000,501	5,508,181	1,083,717	5,945,884
1866....	16,059	77,754	1,149,022	5,884,701	1,165,081	5,962,455
1867....	39,035	113,290	1,103,227	5,740,981	1,142,262	5,854,271
1868....	7,117	37,279	1,090,422	6,303,439	1,097,539	6,340,718
1869....	17,203	84,603	1,241,886	6,838,607	1,259,089	6,923,210
1870....	16,915	80,928	1,142,295	6,712,949	1,159,210	6,793,877
1871....	83,775	394,359	1,251,008	6,544,681	1,334,783	6,939,040
1872....	45,765	199,679	1,092,316	6,828,795	1,138,081	7,028,474
1873....	43,406	199,639	1,236,160	6,755,625	1,279,566	6,955,264
1874....	36,307	188,769	1,583,501	8,861,256	1,619,808	9,050,025
1875....	40,331	205,900	1,426,539	8,296,184	1,466,870	8,502,084
1876....	118,131	593,122	1,541,361	9,125,104	1,659,492	9,718,226
1877....	188,491	920,561	1,488,912	8,622,771	1,637,403	9,543,332
1878....	219,794	998,766	1,576,723	8,955,287	1,796,517	9,954,053
1879....	301,054	1,243,075	1,744,345	9,136,376	2,045,399	10,379,451
1880....	277,790	1,343,967	2,048,515	10,797,067	2,326,305	12,141,034
1881 † ..	174,246	845,125	1,873,095	10,021,026	2,047,341	10,866,151
1882 † ..	51,246	250,764	2,118,471	11,100,145	2,169,717	11,350,909
1883 † ..	120,163	562,318	2,214,310	11,211,615	2,334,473	11,773,933
1884 † ..	100,281	448,556	2,375,155	12,094,899	2,475,436	12,543,455
1885 † ..	78,642	317,527	2,322,731	11,245,981	2,401,373	11,563,508
1886 † ..	43,011	162,201	2,338,529	10,941,501	2,381,540	11,103,702
1887 † ..	52,455	214,029	2,735,545	11,672,688	2,788,000	11,886,717

* A duty of 2s. 6d. per cwt. on British Possessions produce, and of 5s. per cwt. Foreign produce, was in force in 1859. The following years are duty free.

† Butter and butterine included in above Table. The quantity of butter exported during the years named in this Table will be given in the next lecture, under "Butter and Cheese exported."

TABLE XI.—Details of Imports and Consumption for 1887.

	Butter.		Butterine.		Total.	Value.
	Cwts.	£ Value.	Cwts.	£ Value.		£
Denmark	487,603	2,669,125	..	..	487,603	2,669,125
Germany	156,430	793,579	..	..	156,430	793,579
Holland	164,474	851,467	1,172,074	3,546,591	1,336,548	4,398,058
France	416,067	2,264,669	..	..	416,067	2,264,669
Canada	32,623	139,566	..	..	32,623	139,566
United States	52,329	213,712	..	..	52,329	213,712
Norway*	..	..	16,650	61,962	16,650	61,962
Belgium*	..	..	22,895	70,301	22,895	70,301
Other countries	205,379	1,084,651	61,476	191,094	266,855	1,275,745
	1,514,905	8,016,769	1,273,095	3,869,948	2,788,000	11,886,717
	£5 6s., nearly, per cwt.		£3 1s., nearly, per cwt.			

* Butter, "Other countries."

Butterine imported (principally from Holland).

1885	847,263 cwts.
1886	886,573 ,,
1887	1,273,095 ,,

produced is then classified into two or more qualities. That this separation is necessary, may be seen from the following variation in the yield of butter from the cream received from three farms.

(a). One pound of butter was produced from 2·81 quarts of cream.

(b.) One pound of butter was produced from 3·05 quarts of cream.

(c). One pound of butter was produced from 3·37 quarts of cream.

These creameries have proved to be experimental stations, and one fact in particular has come out in working them, viz., that cream kept not more than two days produces far better butter than when churning only takes place once a week.

Some farmers, whilst making their butter at home, sell it in *lumps* as made to factors or to companies, who finish the manufacture by sorting it, and then making the different kinds up for the market. The farmer gets a far better price for the butter so sent into the factory than when put into firkins by himself. It is made up better, finished in a superior style, and made so uniform in quality that it will necessarily command a better price.

The regulations of the Cork butter market have also been modified and adapted to meet the changes which have taken place in the Irish milk industry, so altogether, although great depression has existed in agriculture for many years, the struggle for the survival of the fittest has fostered a spirit of inquiry and emulation. Adversity may, therefore, prove a blessing in stirring up the farmer, and the Government too, to take such steps as shall place our dairy farmers in a right position, by affording them proper education and information, and showing them what is being done by their successful competitors in foreign countries.

Up to the present time very little headway has been made by our dairy farmers in adopting the best method of feeding cattle for producing the most butter, and for the most effective way of getting the cream from the milk. It has been a general practice to let the milk stand in the dairy, irrespective of its temperature, till the cream comes to the top, and the time of churning the butter from the cream so raised has depended much more on the weekly market day than on the condition of the cream itself. If proof were needed for this statement it can be found in the fact that

the different methods of cream separation are of foreign origin, and that there does not appear to be one invention connected with the dairy which can be traced to an English source. The thermometer is absent from nearly all ordinary British dairies, as if there were no connection between temperature and good butter and cheese; and though from painful experience most dairymaids know that the "butter does not come" very well in winter, yet the fact that the coldness of the cream might be altered in a simple way to the proper temperature for churning is not generally known, or if known, not utilised in a practical manner. For butter-making it is essentially necessary that the cream of the milk should be good in quantity and quality, and as almost always butter is made from cream so separated, and not from whole milk, the problem of cream separation has been worked out by many experimenters, and with most satisfactory results. It has been observed that the cream globule varies greatly in size, although it has been calculated that a pound of milk, containing 4 per cent. of butter fat, contains about 40,000,000 of these globules. Small as the largest of these is, yet there are some considerably smaller than others, and it is to this difference in size that certain descriptions of milk, containing the same percentage of fat, and exposed to like conditions, will not yield the same quantity of cream in a given time. The larger globules rise first, and so on to the smallest, which will scarcely rise at all. From a vessel of milk which had been allowed to stand fourteen hours samples were taken from different depths, and the size of the globule measured as accurately as possible, with the following results:—

From surface of cream, diameter of average globule $\frac{1}{6120}$ inch; from lower layer of cream, diameter of average globule, $\frac{1}{6610}$ inch; from six inches below the surface, diameter of average globule, $\frac{1}{8260}$ inch.

In practice it is found that the larger the globule the more easy the cream is churned into butter, and that the reason why the cream of old milch cows is more tedious to churn is that the fat globules are largest just after the cow has calved, and get smaller the longer she remains in milk.

Professor Arnold has given much attention to the raising of cream, and his experiments have led him thus to formulate his views. It must be borne in mind that the average specific gravity of milk is 10·30, of cream 9·85, that fats expand and contract more than water with heat and cold, that water is a better conductor of heat than fat, and that milk deteriorates more rapidly at high than at low temperatures. Then, from these experimental facts, it follows that the difference between the specific gravity of milk and cream is greater the higher the temperature, so that cream will rise quicker at 120° than 60° F. That when the temperature rises or falls, as water is a better conductor of heat than fat, the difference in the specific gravity will be increased when the temperature falls, and decreased when it rises. The conclusion is that as milk deteriorates more rapidly at high than at low temperatures, it should be set shallow at high temperatures, so as to get quicker cooling and less resistance to rising globules, and at lower temperatures the milk should be set deep to allow slow cooling, and the consequent greater yield of cream.

The necessity of procuring, for butter-making, cream which is fairly sweet, has caused the trustees of the Cork butter market to issue to dairy farmers a broadsheet headed, "Ten Points to be considered in Butter-making," and these points are of such great importance and value to dairy farmers that they are here given in full.

Issued by the Trustees of the Cork Butter Market.

TEN POINTS TO BE CONSIDERED IN BUTTER-MAKING.

Recommended for adoption by Thomas Carroll, M.R.I.A., Superintendent Agricultural Department National Education, Ireland, Inspector of Agricultural Schools; and T. A. Forrest, Head Inspector and Chief Superintendent, Cork Butter Market.

1. Keep cow-houses clean. Be sure that cows have pure water to drink, and have the udders perfectly clean by sponging with tepid water before milking. Don't dip the fingers into the milk to moisten cows' teats. Milk the last drop from cow.

2. Strain the milk carefully through two folds of clean muslin—not straining cloth—when setting it.

3. Set milk in shallow-tinned pans. In summer time keep dairy very cool by means of blinds, which may be kept damp in very hot weather. If cold water is to be had, placing the pans in it will cause the cream to rise very rapidly. Cream will rise more rapidly in a cold than it will in a warm dairy, provided the milk is set while it is warm; but if the temperature is very low, the milk should be slowly warmed to 120° before it is set.

4. The cream should be skimmed as soon as it has all risen, which ought to be in about 24 hours after setting. The cream should be kept in a deep cream-vessel; it should be stirred and mixed as each skimming is added.

5. Before churning, cream should be brought to the proper temperature, which is 58° in summer, 60° in winter. This may be done in summer by standing the cream-vessel in very cold water; and in winter by standing the vessel in a tub of warm water; taking care to keep the cream stirred. A clean jar full of hot water may also be placed in the cream-vessel. The churn should be scalded before churning. The cream to be put in whilst the churn is warm; but the temperature of the cream should not be above 60°. If necessary, a little butter colouring of the best description should be put into the cream before churning.

6. Churning should be done twice or three times a week in summer, and once or twice in winter. The churn should be only half filled with cream; it should be worked neither too slowly nor too quickly. Forty revolutions per minute with barrel churn, fifty to fifty-five with Holstein churn. The churning should occupy twenty-five to thirty minutes. The churn should be ventilated frequently if it is a barrel or closed churn. Great attention should be given to the time for stopping the churning; this should be done as soon as the butter comes in very small grains, not larger than a turnip seed. Fresh, clean, very cold water should now be added to reduce the temperature to as near 50° as possible. The churning may go on again until the butter is noticed as being in grains about the size of wheat. No further churning will increase the yield of butter; stop churning, draw off butter-milk. Put in fresh cold water; work the churn to wash the butter. Change the water, adding fresh until the last drawn off is quite clear.

7. Take butter out of churn with "wood hands;" press the water completely from it, either on butter worker or by pressing it with the "wood hands." Put salt, which should be of the best kind, on butter in proper proportion, and mix well, but do not over-work butter. Remember that a pressing, not rubbing action, should always be the way in which butter is worked. The proportion of salt recommended by the Cork Butter Market Trustees is five pints to the firkin of 75 lbs. net for "cured" butter, and not exceeding 2½ pints to the firkin of 75 lbs. for "mild" and "superfine" butter. After salting, set butter aside in cool place for two or three hours, and afterwards give another working before packing. The second working will thoroughly mix the salt, and so prevent streakiness. Every effort should be made to do all the working of butter while it is in a cool state. It works best at a temperature of 56° to 57°.

8. Use nice clean firkins, which should be properly scalded before use, otherwise the butter will adhere to the timber and cause loss; and endeavour by good careful feeding of cows, clean houses for them, clean apartment for milk setting, clean vessels for dairy, clean cold water for butter-making, to put upon the market butter of the finest description.

9. The utensils for producing the best butter need not be costly; care and attention, with a fair knowledge of business, will do more than an expensive outlay on implements. No outlay will compensate for want of care and attention.

10. No dairy should be without a thermometer, for the purpose of marking temperature; a supply of clean muslin for the purpose of straining milk; the "wood hands" for either making butter or taking it from the churn. A "butter trough" is also a useful article.

The Royal Agricultural Society of England has also issued a similar broadsheet.

From the Table before given, showing the number of cows in Ireland as compared with the population, it is evident that Ireland may be a second Denmark as regards butter production if the same care and attention are bestowed on its manufacture. The land throughout is of very good grazing quality, the climate is mild even in winter, and if greater effort was made to produce fresh butter in winter as well as in summer, there is no reason why Irish butter should not hold a high place in our British market, and Ireland become famous for her fresh butter supply as she was formerly for her salt butter. She possesses great advantages as compared with the English and Scotch farmer. She is provided with two dairy schools mainly supported by the Government, has a staff of practical teachers for the education of young men and women in dairying, and, above all, she has an ample supply of good land for grazing purposes, and a population not nearly large enough to consume her dairy produce. In such circumstances it would be surprising indeed if no change were perceptible in dairy agriculture, and it is pleasant to record that the Irish dairy farmers are making rapid progress, some of them taking the highest position as butter makers as well as dairy farmers, their farms and dairies being managed on the most correct sanitary and scientific principles. Mr. Barter, of St. Anne's-hill, near Cork, has shown that it is not difficult to supply fresh butter all the year round, and that good feeding, cleanliness, warmth, care, and attention are never thrown away on cattle, for they return the outlay with excellent interest.

It is only for the farmers in general to go on the same lines, and carry out what is insisted on by Professor Carroll, Superintendent of the Agricultural Department of National Education, Canon Bagot, and others who have already done so much to improve the quality of Irish butter, to attain the position they formerly occupied as the best of butter makers. The dairy industry is a large one, as may be

gathered from the following data. In 1886, there were 1,418,726 milch cows in Ireland, of the estimated value of £25,537,068, and they were distributed as follows:—

Province.	Gross Acreage.	No. of Cows.	Acres per Cow.
Munster....	5,934,682	545,517	$10\frac{4}{5}$
Ulster......	5,322,321	443,819	12
Leinster....	4,838,510	236,703	$20\frac{1}{2}$
Connaught..	4,233,240	192,687	22

Much of the butter produced passes through the Cork butter market, and the regulations for assorting and branding qualities are so rigid, that they are worthy of attention as showing that the Cork branded butters are reliable as to quality.

The quantity which passed through the market in 1883-4 was 229,751 cwt., and of the value of £1,153,375, and, on comparing the different qualities which passed through in that period with 1886, it is satisfactory to notice that in the salt butter the first quality had increased 7·3 per cent., the second 12·5 per cent., whilst the third, fourth, and fifth qualities decreased 25, 28, and 63 per cent., respectively. Of the entire butter sent to market in 1883-4, the proportion of mild cured was 8·6 per cent.; in 1886, the proportion was 13·4.

These results are indicative of progress, and as it is only by well-directed and sustained enterprise that success can be attained, it is hoped that further improvements will continue to be made till, at no distant date, we shall have "Irish roll" butter as generally known in our markets as "Normandy roll" is at the present time. In certain localities it has a good name now, but, unfortunately, it is not made all the year round.

From the large quantity of butter imported, it is evident that we are largely dependent on other countries for our consumption. Notably Denmark, Holland, France, Scandinavia, and Italy compete for this trade, and perhaps of the countries named none have made such progress as Denmark and Scandinavia. Though not favoured with a warm climate, these countries supply butter during the whole year, and the butter industry has perhaps made greater progress in these than in any other part of Europe. Denmark, like Ireland, is strictly a dairy country, and many years ago the dairy farmers combined to start agricultural societies in different districts. They saw that it was necessary to have experimental stations where theory and practice could be combined, and twenty-seven years ago Professor Segelcke was appointed professor of dairy husbandry. For ten years his work seemed to be without fruit, but now it is said of him, "He has changed the system of management of a nation in one important branch of its manufacture." Denmark now stands first and foremost as a dairy country. Danish butter is favourably known in all parts of the world, and whilst the fresh has a good name, the salt butter is exported to tropical countries in large quantities, and fetches a better price than any other brand of butter. Experiments were made, under the direction of the agricultural societies, to find out improved methods of cooling milk to set for cream, and it was apparent that in the cold seasons of the year milk could be set in deep pans without difficulty, and the cream thus obtained was of better quality than that collected in the ordinary way. The butter produced from such cream was greater rather than less, the quality was superior, for it had a better flavour and possessed superior keeping qualities. It remained to put these facts into working order, and this was accomplished by placing the temperature of the dairy under control in winter and summer by the employment of water for cooling the milk, at a temperature at or near 40° Fahr. Mr. J. G. Schwartz was the inventor of the process, and after it had been critically and experimentally tested by Professor Segelcke, its use was recommended, and on account of the advantages of the system it rapidly became popular. The method is to have a cistern in which are placed tins containing milk, whose dimensions are about 20 inches deep and eight inches wide. In summer these tins are covered with lids, having two perforations to let out the escaping gases, but in winter, when the temperature of the atmosphere is low, they need not be so protected. These tins are placed upright in the cistern, through which a stream of very cold water is made to flow, or ice is used if necessary, so that the temperature of the milk is brought down quickly to from 40° to 42°. The temperature of the room in which the milk is being cooled in these cisterns is kept as low as possible in summer, but not lower than 50° in winter. The benefit derived from this system is that not only is the cream perfectly sweet, but the milk from which it is skimmed can be converted into cheese.

Other systems for cooling milk have sprung

up since then, notably the one called the Cooley system, after its inventor. It differs from the Schwartz in the following main particulars. The tins used have a tap at the bottom for letting out the skim milk, a graduated section of glass in front—through which the milk can be seen and the indication of a thermometer in the milk can be read, and a tight-fitting lid to permit the tins to be covered entirely with water.

Keeping at a temperature at from 40° to 50° in spring and summer, and at 40° in winter, the cream will rise in twelve hours. By actual experiment, Mr. Cooley found that milk kept at 40°—45° threw up cream more quickly than at any other temperature. The drawback to Cooley's tins is that in them is contained the objectionable odours that arise from milk during the time it is cooling. It possesses many advantages, however, and of all the Schwartz modifications it seems to be the best for the ordinary dairy farmer.

The Hardin system differs from the Cooley in the use of cold air instead of cold water.

The separation of milk and cream on standing led to the consideration of mechanical methods for effecting the same separation; and as necessity is the mother of invention, experiments were made to practically try whether by centrifugal force the lighter cream could not be separated from the heavier milk. The necessity for using a mechanical method of separation was pressed upon the dairy farmers in those districts where ice was not attainable for cooling the milk, but where for their own prosperity it was essential that they should have sweet cream. The first machines made were of the clumsiest description, but De Laval in Sweden, and Burmeister and Wain in Denmark, constructed a centrifuge for this purpose which left little to be desired, and although both work well, the "Laval" now exhibited, is so simple in construction and management that it has been adopted in milk factories and large dairies in this and other countries. The method of operation is simple enough. The milk while still warm from the cow is placed in a milk can, from whence it runs into a spherical vessel of about ten inches in diameter, and which makes from 6,000 to 7,000 revolutions a minute. The heavier part of the milk is by its own weight forced to the outside, and, by a simple contrivance, this portion, which is the separated milk, is forced up an outlet-pipe, while the ligher portion—the cream—rises round the central part, and overflows into a tray from which it is delivered by a pipe. The rate at which the milk enters the machine is regulated by the speed of revolution. The advantages conferred by this machine are great, but to those who make skim-milk cheese from the separated milk, the machine takes too much of the fat away, in fact the separation is too complete.

Where the skim milk is thus made into cheese, it is important to have it quite fresh and sweet, and this machine is perfect in this respect. Methods of preservation are not needed, loss from souring is reduced to a minimum, and there is no elaborate cooling apparatus.

Against all these advantages, there must be set the cost of motive power, which in small dairies is out of proportion to the benefit obtained.

De Laval's cream separator was tried in 1879, at the Kilburn Show of the Royal Agricultural Society, with the following results as given by Dr. Voelcker:—

TABLE XII.

	New milk used.	Skim milk from Laval's cream separator.
Water	87·72	90·71
Butter-fat	3·45	·22
*Casein	3·12	3·31
Milk sugar	5·11	5·12
Mineral matter (ash)	·60	·64
	100·00	100·00
*Containing nitrogen	·50	·53

"Milk well skimmed in the ordinary way contains on an average ¾ per cent. of butter-fat, whereas the skim milk from "Laval" did not retain quite ¼ per cent.

"Thus of the 3½ per cent. of butter-fat (in round numbers), 3¼ per cent. were obtained in cream, only ¼ per cent. of fat passing into the skim milk, affording a striking proof of the perfect manner in which butter-forming constituents are separated in passing through Laval's rotatory machine.

"Had the milk been set in pans and skimmed thoroughly in the usual way, instead of 3¼ per cent. of pure butter-fat, only 2¾ per cent. would have been obtained from the new milk; or in other words, by Laval's separator 93 per cent. of the butter-fat was obtained in the cream, and 7 per cent. only left in the milk, whilst by the ordinary plan of skimming, only 78½ per cent. of the butter-fat of milk passes into the cream, and 21½ per cent. remain in the skim milk.

"In another trial at Kilburn, on July 8, the separa-

tion of butter-fat from the milk was not so perfect as on first trial, as will be seen from the following analysis of skim milk produced:—

Water	90·49
Butter-fat	0·46
Casein	3·01
Milk-sugar	5·31
Mineral matter (ash)	0·73
	100·00

"In the second trial it will be seen that nearly ½ per cent. of fat was contained in the skim milk.

"The cream obtained by means of the separator had the composition:—

Water	66·12
Butter-fat	27·69
Casein	2·69
Milk-sugar	3·03
Mineral matter (ash)	0·47
	100·00

"Good cream obtained in the ordinary way by skimming milk, seldom contains as much as 25 per cent. of butter-fat, and quite as much casein as was contained in the cream from Laval's machine.

"The Kilburn trials thus show that cream from milk which has been passed through Laval's separator is richer in butter-fat than that obtained in the usual manner.

"On the occasion of the Dairy Show held last October, at Islington, opportunity was given of examining the skim milk obtained by Laval's machine. This sample was composed:—

Water	90·82
Butter-fat	0·31
Casein	3·31
Milk-sugar	4·77
Mineral matter (ash)	0·79
	100·00

"Another portion of the same milk after having been skimmed in the usual way contained:—

Water	89·25
Butter-fat	1·12
Casein	3·69
Milk-sugar	5·16
Mineral matter (ash)	0·78
	100·00

According to these trials nearly four times as much butter-fat was left in ordinary skim milk as in the separated milk obtained by the Laval machine. The per-centage of butter-fat was determined with great care, and checked to avoid errors.

Further practical experiments have been made at the Bath and West of England Show, held at Newport during the time this lecture was being prepared for publication. The quantity of milk operated on was 14 gallons, which would weigh about 144½ lbs. Full details are given in the report how the milk was prepared for the different experiments, but the results are as follow:—

TABLE XIII.

Methods.	Milk operated on.	Butter obtained.	Fat in Skim Milk.
		lbs. ozs.	Per cent.
Separator		4 13	0·11
Jersey Creamer		4 12	0·33
Rymer Pan	14 gallons,	4 12	0·53
Shallow Pan	or	4 9	0·40
Devonshire System	144½ lbs.	3 15	1·01
Canadian Creamer		3 14	1·05
Schwartz System		3 10	0·98

It will be apparent from an examination of the Table that the action of the "Separator" is well-nigh perfect, being far superior to all the other methods tried in separating the fat. The trials were, however, to measure the quantity of butter which could be produced, and for this purpose they are defective, because it is evident that to make such a competition complete, the quantity of water and curd in the finished butter should have been estimated as well as the fat left in the separated or skimmed milk. A comparison of the weight of butter made, and the quantity of fat left in the milk, will show that the butter produced in the trials could not have been of uniform composition. The results, however, show the value of the "Separator" to the dairy farmer, and for this reason I have introduced the Table.

The machinery of the cream separator has been modified to be made available for the rapid determination of fat in milk. The apparatus employed is called a "lactocrit," and consists of an upright steel spindle dropped into the frame of the separator after the removal of the separating drum. The spindle is provided with a flat circular disc, and contains twelve holes bored outwards to receive especially made test tubes. These tubes are made of thick glass, which are at each end cased in metal, the lower end fitting into a metal cup to protect the glass from fracture during the time it is in the disc. The principle of the lactocrit is that when a mixture of acetic and sulphuric acid is added to milk and heated, the casein remains soluble, and it is then practicable at a temperature of

about 100° Fahr., and by rapid centrifugal motion, to separate the fat from the milk. The column of fat is by the special scale on the test tube itself expressed in fat per-centages.

The fat determination is thus made; ten cubic centimetres of milk are pipetted into a dry glass flask, and the same bulk added of acid concentrated mixture, which consists of ninety-five parts of acetic and five parts of sulphuric acid. The flask containing the mixture of milk and acid is then corked, and either put into boiling water or into a bath for ten minutes. The mixture is then well shaken, a little moveable cup covering the end of the test tube is filled with it, and the tube itself is filled with the mixture by pressing the cup into its place. Any surplus liquid is discharged through a small hole at the opposite end of the tube. The disc is specially heated to a temperature of 100° Fahr., and the test tube inserted cup downwards.

The spindle is made to revolve for five minutes at a speed of 6,000 revolutions per minute, and the fat separation is then complete. The machine is allowed to run down, the tube is taken out and the little orifice stopped by the finger. The fat column is then read off, each degree being equal to 0·1 per cent. of fat in the milk tested.

It will be apparent that twelve samples can be tested at a time, and as the indications are correct when the tubes are properly graduated, the method is rapid and reliable.

At the Munster Dairy School, also, careful experiments on milk-skimming have been made. A certain quantity of milk was divided into four portions and thus treated:—

1st portion, in ordinary shallow tin pans, for 24 hours.

2nd portion, in Schwartz cans, cooled in ice water, 18 hours.

3rd portion, in Cooley cans, cooled in ice-water, 18 hours.

4th portion, passed through the centrifugal separator.

Results:—The greatest quantity of butter was got from the separated cream, being 16 per cent. more than from the cold-water systems, and 24 per cent. over the ordinary pans.

It will thus be apparent that for butter production the Laval separator is superior to any other system in use, and the increase in the yield of butter will go far in actual practice to compensate for the cost of working the machine.

This machine has also worked another change. Till within recent years Devonshire clotted cream was extensively used as an article of diet. But as it is partly-made butter, it cannot be added to tea or coffee without the fat separating out, and, therefore, it is chiefly used with fruit. The separated cream can, on the other hand, be used in any way, it mixes with milk and hot beverages perfectly, and, altogether, it is largely superseding clotted cream. Some that is sent to the London markets is prepared and packed in strict accordance with scientific requirements, and it will keep sound for several days, even in the hottest weather.

Sweet cream, when made into butter, does not yield so well as cream slightly soured, and as the Danish cream, both skimmed and separated, is sweet, it is soured by being brought to a temperature of 62°, and the addition to it of $\frac{1}{2}$ to $\frac{3}{4}$ per cent. of sour buttermilk. Lactic fermentation is thus set up, and in the space of 24 hours or so sufficient acid is developed to give the nutty flavour considered of such value in the class of butter so manufactured. The many reforms in butter-making, originated and perfected by Professor Segelcke, have, as a matter of course, raised Danish butter to a very high position, while the theoretical and practical education afforded by the dairy schools and farms connected with them has given the country a staff of workers who make the best use of their knowledge, and enable the Danish dairy farmer to make the most of his produce. In Sweden and Norway, the Danish system of dairying is in operation, and the Government schools are doing for these countries what the Danish schools have so admirably accomplished in Denmark.

The Danish and Swedish butters have for long periods been used in the north of England and Scotland, but only fifteen years ago this butter first found its way into the London markets, and it is now the best salt butter imported, and commands the highest average price. Before the Danish and Prussian war the butter produced in these countries found its way here through the Kiel and Hamburg markets, but after the cession of Schleswig-Holstein to Prussia, a line of weekly steamers has been started between Copenhagen, Newcastle, Hull, and London. The drawback to the supply of fresh butter is that it takes four or five days to get butter from Denmark or Sweden, whilst the French butter can be sent here in twenty-four hours, and very frequently Normandy butter made on a Monday morning is sent into

consumption in London on the Wednesday following. It is not unlikely that, with the growing demand for fresh butter, an incentive may be given to send us fresh as well as salt butter, and especially so when the difference in price between the two kinds becomes greater. Holland, which sends large quantities of butter to this country, and the substitute, "butterine" —but which now must be designated by its legal name, "margarine"—has a large farming industry; but beyond the cleanliness of the dairy operations, the cool position of the dairies, the care taken in manufacturing the butter, and the energy of the workers, there is nothing more to say respecting dairy farming. In fact, the farmers themselves acknowledge that they are behind their Danish brethren, as they have sent to Denmark a commission of inquiry, and on its recommendation established an experimental dairy at Leeuwarden, and fitted it up to carry out the deep setting system of Schwartz.

The Normandy system of butter-making cannot be dismissed so easily, for Normandy butter has obtained for itself such a high reputation for uniformity and quality, that it demands special attention.

The land producing the very best butters is rich, old pasture, and the hay produced from it is of sufficiently good quality to feed the cows upon during the winter months without the use of cake or roots. In fact, roots are avoided altogether, because as butter is made throughout the year, every care is taken that the food given shall not taint the butter.

The butter is made from sour cream, each skimming being kept separate till the time of churning, when the different skimmings are mixed together. Some makers add to the cream a little new milk, but this is not a uniform practice. Churning takes place twice a week at least, a barrel churn being used. As soon as the attendant is satisfied that the butter has come, the churning is stopped, the buttermilk withdrawn, and cold fresh water substituted. This is repeated till the water is drawn off quite clear, and then the butter is taken out of the churn, and worked into a lump ready for the market. Until the Franco-German war the butter which was sent to this country was salted, but an incident of the war effected a complete revolution in this respect, and opened up a special industry, which has continued to grow till it has attained enormous dimensions. When Paris was besieged by the Germans, a large quantity of pure fresh butter in lumps was shut out from Paris, and found its way to London. This butter, known locally under the name of Paris fresh, could not, on account of its freshness and variety of colour, readily find a market here. One London firm was, however, impressed with its quality, and working it up to secure uniformity of colour, sold it under the name of "Brittany" butter. It soon became popular, and as it was really a good butter and fairly regular in quality, other firms embarked in the trade, and at last the making up of the butter for the London retail market was transferred to Normandy. Central factories have been established for working the lump butter bought from the farmers, and the two firms of Bretel Freres, of Valoynes, France, and Messrs. Lepelletier, of Carenton, have almost monopolised the trade, each firm sending to the English markets from eighty to one hundred tons a week. It is admitted that the butter *per se* is not so good as some of the Danish butter, but from the great demand for it it can be seen what can be done by careful selection, uniformity of colour and quality, proper making and packing, to bring such a butter into the highest place of honour with the consumer. The farmer makes the butter, and the merchant works it up for the market. It is brought to the market by the farmer in lump, covered with a clean white cloth and in a wicker basket. It is then examined by the buyer, sorted as to quality, and immediately sent to the factory. At the factory the butter is again carefully sorted, the finest being selected for best rolls, the next quality for second rolls, and fresh lumps in baskets. Below this there are three other qualities salted more or less, the first with three per cent. of salt, and the other two with from five to seven per cent.

The method adopted for working the butter for rolls is as follows:—The butter is put into a machine something like a chocolate machine in quantities of about one cwt. In this machine the plate revolves under the rollers, and when the butter is rolled out flat it is folded back by a wooden slicer, and the operation is repeated till the butter becomes exactly alike in texture and quality. In winter the butter is very often white and colourless, from the cows being fed principally on hay, the desired colour is then imparted by the addition of liquid annatto, but in summer no colouring whatever is used. The butter is made up into two-pound rolls without being touched by hand, and everything is done to insure cleanliness and free-

dom from taint. To guard against fermentation the butter is in summer usually made in the night or early in the morning, and taken to market at five or six o'clock in the morning. Messrs. Bretel Freres cool theirs in underground caves cut in the solid rock before and after being made up, to insure its arrival in London in good condition.

Such is the history of Normandy "roll" butter, so well-known and appreciated by the British public. It is apparent that there is no superiority in this butter as sent from the dairy, and there is no reason why proper combination should not in England or Ireland achieve the same result by the same means.

Owing to the increasing demand for fresh butter of the quality, flavour, and uniformity of the "Normandy fresh," efforts have been made to collect butter from farmers in certain districts, and re-make it in central factories. In Devonshire, Sussex, and other districts, the experiment has been successfully tried; but the great drawback has hitherto been that there is no winter supply, and consequently the factories have to be closed during the winter months. Unfortunately for such producers, butter is required in winter as well as in summer, and it follows, as a matter of course, that the distributor, to avoid failure of winter supply, trades with those firms who send to market all the year round. The winter will not be so good as the summer butter, but it is produced nevertheless, and this trade will remain in present hands until a general movement is made to produce butter in winter. The expense of production, though greater, will be covered by the price realised for the finished article, and the few farmers who have gone into this trade have no reason to be dissatisfied with their adventure.

In the milk factories good butter is produced, and rivals in every respect its foreign competitor; but here the winter supply is very small also, and the quality not good. Some of the large butter dealers are striving to increase the winter supply, and as they have capital at command, and an interest in possessing more than one market from which to draw their produce, they are likely to stimulate production, and to hasten the time when it will be possible to obtain in quantity British-made winter butter.

Attention has also been paid to the wrapping and packing of butter. The fresh is usually on sale in boxes containing twelve rolls of two pounds each; and even Irish butter is now sold in less quantities than the seventy pound firkin, the cases of special size and form invented by Canon Bagot being particularly serviceable. The last decade has been a period of special progress in the improvement of packing goods for consumption, and much of this improvement has been due to the originality and foresight of our foreign competitors, who have never wearied in putting their goods before the public in the most taking manner.

Butter.—Its Composition.

Butter should consist entirely of the fat of milk, with a small quantity of water remaining in it; but this standard of perfection is in practice never reached, for it contains in addition a portion of curd or cheesy matter which varies considerably in quantity, and salt to preserve it. If a small quantity of butter be slowly melted in a glass vessel, the water can be seen to slowly separate into a lower layer, while the other portion—which at first has a white appearance, through the curd and salt being diffused throughout the butter-fat—will slowly divide itself into a stratum of oil and a lower layer of curdy matter and salt. The quantity of curdy matter present in a sample of butter is a good indication of the amount of care exercised in making it. This curd, which is derived from the butter-milk left in the butter, can be almost completely washed out when the butter is taken from the churn, but as time and labour are involved in this operation, as well as a loss of weight, careless or fraudulent makers do not wash sufficiently, and hence the presence of the curd. It has been previously pointed out that the lactic ferment causes milk to become acid by the conversion of milk sugar into lactic acid, and as the cream from which butter is made is usually sour, it follows that the lactic ferment is present in all the sour butter-milk left in the milk. The consequence is that this ferment acts on the remaining sugar, and also on the nitrogenous matter, and chemical decomposition proceeds so rapidly that in a few days such butter has an offensive smell and odour, and is not fit for the table but for cooking purposes only. If, however, the curdy matter be worked out by washing, the butter-milk will at the same time be got rid of, and butter thus freed from impurities will even in summer remain in good condition for some days. Its keeping properties are improved by the water being pressed out as much as possible, as the butter-fat, when comparatively free from water, is more compact, and thus resists the action of the air and

hurtful ferments. In some parts of the country water is used as an adulterant, and a glance at the following Table will show the great variations in moisture:—

TABLE XIX.—Analyses of Ten Representative Samples, Showing the Ordinary Variations in the Composition of Butter-fat.

No.	Per-centage.				Butter-fat.			
	Water.	Salt.	Curd.	Butter-fat.	Specific gravity at 100° F.	Per cent. fixed acids.	Per-centage soluble acids as Butyric acid.	Melting point. F.
1	7·55	1·03	1·15	90·27	913·89	85·56	7·41	85
2	11·71	3·60	0·95	83·74	911·45	88·24	5·41	90
3	16·89	8·56	1·23	73·32	911·48	88·82	4·64	89·5
4	16·28	3·32	1·56	78·84	912·79	86·00	7·00	88·5
5	11·42	1·29	1·12	86·17	910·47	88·53	4·84	90
6	12·55	0·89	0·74	85·82	910·20	89·00	4·57	90
7	12·96	2·43	1·25	83·36	912·51	88·25	5·45	89
8	13·40	1·39	2·03	83·18	911·67	88·72	5·07	90
9	12·05	0·96	1·95	85·04	911·04	87·51	5·28	83
10	14·62	1·48	1·88	82·02	910·70	89·00	4·50	91

Butter-fat, from its instability of composition, affords evidence that it must differ greatly from ordinary animal fats. Some chemists have contended that this difference is very slight, and that by the addition to the more liquid portions of animal fat of a little milk the artificial product compares favourably with butter, both in composition, appearance, and flavour. In fact, this mixture is the "Margarine" of commerce, which will be more fully described when treating of it as a butter substitute.

Butter-fat actually is a combination of certain fatty acids with glycerin. Some of these acids are solid at ordinary temperatures, others liquid, some soluble in water, and others not. Their action with hot water divides them into two classes, the oleic, stearic, palmitic, and myristic acids being insoluble, and capric, caprylic, caproic, and butyric soluble in hot water.

These acids do not form with glycerin a simple mechanical mixture, but a complicated chemical compound, which is somewhat unstable in composition, and is easily acted on by ferments and oxidised by exposure to the air. The odour of some of these acids, notably the butyric and caproic, is very marked, and the strong offensive smell of certain specimens of decomposed butter can be traced to the presence of these volatile acids in the free state.

Proximate Analysis of a Superior English Butter.

Fat	90·27
Curd	1·15
Salt	1·03
Water	7·55
	100·00

Fatty Acids in Butter.

(100 *parts taken.*)

Butyric	6·13
Caproic, caprylic, capric	2·09
Palmitic, stearic, myristic	49·46
Oleic	36·10
Glycerin	12·54
	106·32

Produced by taking up water during the analysis.

Composition of Fatty Acids in Butter.

Butyric	$C_4 H_8 O_2$
Caproic	$C_6 H_{12} O_2$
Caprylic	$C_8 H_{16} O_2$
Capric	$C_{10} H_{20} O_2$
Myristic	$C_{14} H_{28} O_2$
Palmitic	$C_{16} H_{32} O_2$
Stearic	$C_{18} H_{36} O_2$
Oleic	$C_{18} H_{34} O_2$

From the foregoing Table of ten representative samples it will be seen that the per-centage of "fixed" acids in fresh butter varies from 85·56 to 89·00 per cent., and of volatile acids from 4·50 to 7·41 per cent. These variations of composition of genuine butter make the detection of adulterants in butter a matter of great difficulty when the per-centage of foreign fats is small. The origin of the butter not being known to the analyst, he has to determine whether the results of his analysis fall within the limits of the composition of a genuine butter, and as these limits are somewhat wide, the butter under examination has the benefit of all doubt on the point. Consequently adulterated butter may have been passed as genuine, not because its nature has not been suspected, but simply because the chemical composition was not inconsistent with some descriptions of genuine butter. The analyst's difficulty is also increased by the gradual change wrought in butter by keeping. The fixed acids increase, and the volatile acids diminish, causing the sample to partake more of the character of a mixture of fresh butter and foreign fat. As genuine butter is such, whether fresh or old, it follows that the greatest discrimination has to be exercised in butter analysis, and the skilled analyst will take into account many phenomena that arise during the examination, as well as the actual results obtained, to guide him in coming to a righteous judgment. It may be observed, broadly, that however skilfully made, an adulterated butter will generally betray itself during a careful analysis; but it is only the analyst of large experience who is able to correctly interpret what he has observed during the progress of the analysis.

TABLE XV.—Analyses of Samples of Butter after Keeping.

No.	Original Butter.		Time kept.	After Keeping.	
	Specific Gravity at 100° F.	Per-centage of Fixed Fatty Acids.		Specific Gravity at 100° F.	Per-centage of Fixed Fatty Acids.
			Weeks.		
1	912·28	87·30	12	910·74	88·97
2	911·58	87·80	7	909·19	90·00
3	913·89	85·50	7	913·57	85·72
4	911·78	87·40	6	911·00	87·97
5	911·06	87·72	8	910·61	88·40
6	911·48	87·65	6	911·33	88·00
7	912·39	—	12	911·28	—
8	912·18	—	12	910·39	—
9	912·28	—	12	911·24	—
10	913·97	—	16	913·92	—
11	910·19	—	8	908·15	—
12	910·62	—	8	910·13	—
13	911·04	—	6	910·75	—
14	911·40	—	8	911·00	—
15	910·70	—	5	910·57	—

Table XV. shows the changes referred to as taking place in butter after keeping.

The chief butter adulterant is foreign fat. These animal fats are practically free from volatile acids, their melting point and specific gravity are lower than butter, as will be seen in this Table:—

TABLE XVI.

Description of Sample.	Specific Gravity at 100 F.	Per-centage of Fixed Fatty Acids.
Mutton suet	902·83	95·56
Beef suet	903·72	95·91
Fine lard	903·84	96·20
Dripping (commercial)	904·56	94·67
Dripping, mutton (genuine)	903·97	95·48

From a careful comparison of the composition of butter and animal fats, it will be observed—

1. That the specific gravity of butter is higher than animal fat.

2. That the melting point of butter is higher than animal fat.

3. That the butter contains more or less volatile acids, whilst animal fats contain none.

These facts form the data for the determination of the genuineness of butter.

The specific gravity is taken at a temperature of 100° Fahr., because all fats found in butter or its adulterants are liquid at that temperature, and the melting point in water is easily determined. The manipulation necessary for separating and weighing with precision the fixed fatty acids, and of estimating the volatile acids, is too refined to admit of description. The general principle is well-known to analysts, and in another form it is equally within general observation. Thus soap, which is well-known to all civilised nations, is nothing more than a combination of fatty acids with an alkali, soda being the alkali in hard, and potash in soft soaps. The natural fat is, as before stated, a combination

of fatty acids with glycerin. In the manufacture of soap, the alkali is made to take the place of glycerin, the glycerin being now recovered from the soap lees and sent into consumption, the combined fat and alkali becoming the soap of commerce.

Similarly in butter analysis, only in a more refined manner, the fat of the butter is acted on by an alcoholic solution of potash or soda, the saponification is completed by heat, and when this stage has been reached, the alkali has completely displaced the glycerin. This butter soap is not in a dry but in a wet state, being dissolved in the water in which the alkali was dissolved. The next stage in the analysis is to separate all the acids from the alkali by the addition of an acid which has a stronger affinity for the alkali than the fatty acids have. The acid used is sulphuric acid. When this is added, the fatty acids are thrown out of solution, those not soluble in the water begin to assume a curdy appearance, and thus there are the soluble acids in the water, and the insoluble acids suspended through it. The insoluble acids are then separated and weighed, and the soluble ones determined by volumetric analysis.

As weighed quantities of butter were operated upon, and the strength of the alkali and sulphuric acid accurately determined, it follows that the results obtained have only to be worked into per-centages of volatile and fixed acids, and this part of the operation is complete. The salt and curd are determined in another operation, and thus the per-centage composition of the butter is built up.

In order to put these general principles into practice, the following Table is given to show the composition of what was known formerly under the name of butterine, but which from the first day of this year has to be called margarine.

TABLE XVII.

Per-centage of				Fat.			
Water.	Salt.	Curd.	Fat.	Specific gravity at 100° Fahr.	Per-centage of fixed acids.	Per-centage of soluble acids.	Melting point.
14·30	3·81	0·48	81·41	903·84	94·34	...	82° F.
11·21	1·70	1·73	85·36	902·34	94·83	·66	78° ,,
12·33	4·00	1·09	82·58	903·15	95·04	·47	79° ,,
5·32	1·09	0·67	92·92	903·79	96·29	·23	81° ,,
13·21	3·99	1·07	81·73	901·36	95·60	·16	78° ,,

The above samples were carefully made, were very free from offensive smell, and their flavour not objectionable, although deficient in character.

Their specific gravities, melting points, and the proportions of fixed and volatile acids, reveal their character as spurious butter, but the care with which such butter substitutes are prepared, and the large quantity imported, afford strong evidence of the value of the public analyst in protecting the consumers of butter.

The quantity of margarine imported into Great Britain, principally from Holland, during the last three years is as follows:—

In 1885..........	847,263 cwt.
1886..........	886,573 ,,
1887..........	1,273,095 ,,

It was formerly imported from the United States, but legislative regulations have there interfered with its manufacture and sale, and its manufacture has subsequently been diverted mainly to Holland. The history of the manufacture of this butter substitute is somewhat remarkable and sensational. It has been long contemplated by chemists that the fat of the cow might in some way or other be made to act as a substitute for the fat found in the milk of the same animal. While the composition of animal fats was not known, speculation in theories of substitution was common enough, and in 1869 M. Hippolite Mége, of Paris, was induced, by the pressing necessity for a regular butter substitute supply during the German invasion, to turn his attention to the subject. In that year he took out a patent which had for its object the making of neutral products new by their nature. His invention was said to be based on the deductions of modern science which proves—

1. That odoriferous colouring matters, volatile and becoming rancid, do not pre-exist in the natural fats called suets.

2. That they are developed by the action of the organised tissues under the influence of fermentation, heat, or chemical agents.

3. That the fats of milk called butter are only fatty bodies from fat modified first by its cellular tissue, second by the organised tissues of the udder.

In applying these so-called facts industrially he formulated his process thus—

1. From suet is obtained a virgin fat without odour or smell of fat, and like best fatty bodies.

2. A variety of true butter taken at its source, formed as in ordinary lactation, and

superior to butter from milk by the length of its preservation.

In other words, he meant to say that his process consisted of the two distinct operations of obtaining from beef fat, at a low temperature, a pure sweet oil without smell or taste, and of churning with this sweet oil milk or cream for the manufacture of artificial butter. From this beginning has sprung the large margarine manufacture, and of which substance we are very large consumers.

Formerly this oil, or "Oleo" as it is now called, was a bye-product in the production of stearin for stearin candles, but now the oleo is in greater demand than the stearin for the manufacture of artificial butter. A new outlet is found for the stearin in the manufacture of "refined" American lard, which is composed of lard, stearin, and cotton-seed, or earthnut oil, and sent in large quantities into this country. The oleo is thus manufactured:—The thick and thin fat of bullocks is obtained in a perfectly fresh state from the slaughter-houses of Paris, London, and other large cities. The fat is selected with very great care, and allowed to cool thoroughly till hardened. It is then chopped into very small pieces to rupture the cellular tissue, and put into mills with toothed rollers to tear the tissue still more, to allow of the free flow of the oleo. The torn fat is then put into steam-jacketed boilers, and gently heated to a temperature not exceeding 122° Fahr. for about an hour and a-half, but no water is allowed to enter the boiler. The fat that will run off at the end of the operation is drawn off by a syphon, and the residue left in the boilers is then mixed with mutton and other fats, and the product sold for soap-making.

The proportion of melted fat fit for oleo is about 63 per cent. for soap and candles; 20 per cent. and 17 per cent. is lost in waste material. So rapidly is the work performed, that frequently the fat of animals killed in the morning is in the evening made into oleo.

The syphoned oleo above mentioned is allowed to remain in the tank two hours, to admit of the sinking of the refuse. The purified fat is permitted to cool slowly, and when hardened, it is cut into pieces of about 2 lbs. weight each, and each piece is wrapped in a strong cloth, and submitted to hydraulic pressure to separate the olein from the more solid stearin. The proportion of olein is about 66 per cent., of stearin 33 per cent.; loss 1 per cent.

The oleo is allowed to cool in a darkened room, having a temperature of about 58°, and in six or eight hours the oleo is ready for the margarine factory. The margarine is made in different ways, but the most approved quality is thus manufactured. A certain quantity of milk is put in the churn, then oleo at a temperature of 103°, earth-nut oil and butter in lumps in the proportion of from five to fifty per cent. Annatto extract is added for colouring. The churning takes place at 86° Fahr., and lasts about an hour. When the churning is completed, the contents of the churn pass through a sluice of wood into a vat, and the contents of the sluice are, in passing down, artificially cooled by ice-cold water. This operation granulates the liquid margarine, and between 40° and 50° Fahr. the margarine hardens and aggregates. It is then worked, salted, and prepared for market. This industry is a very large one, and it is computed that 40,000 tons of oleo, olein, or oleo-margarine, are imported into Holland annually.

The rapid demand which has sprung up for this production has naturally caused agriculturists in every country to be opposed to its manufacture and sale. If always sold under its own name, there is no ground for complaint; but it has been proved that in some countries, notably in France, about twelve months ago, certain brands of butter were made up with different proportions of margarine, and this adulterated butter found its way into London and other large towns. The French Government has now stopped the adulteration, but in almost all countries where butter is a staple article of trade, restrictions are put upon the sale, and sometimes on the manufacture, of margarine. In the United States all manufactories have to be licensed, and a duty is put upon it. The effect of the legislation has been that the export trade in it has practically died out, and other countries, not so handicapped, have monopolised the business.

In Germany, the mixture of butter with margarine is absolutely prohibited. In Holland, Belgium, Denmark, Scandinavia, and Russia, special enactments are in force, different in each country, it is true, but yet very restrictive in all. The Danish laws against general trade misrepresentations are very severe, and, up to 1884, were punishable by imprisonment from five days to two years, with a diet of bread and water. In 1885, margarine was exempted from this law, and specially dealt with. Fines can be imposed under the present law, varying from £11 to £110, coupled with the confiscation of the offending article.

In the United Kingdom a Margarine Act came into operation on the first day of this year, but up to the present time the imports of margarine for the year have been larger than during a like period in any previous year.

The Act gives a legal definition of butter and margarine, and offences are punishable by penalties not exceeding £20 for a first, £50 for a second, and £100 for a third or subsequent offence. Inspectors have power to visit factories, which must be registered, to obtain samples from shops and factories without purchase, and to do other things considered necessary for controlling the legal sale of margarine.

Much of the margarine imported into the country is carefully made, nicely packed, and much cheaper than bad butter. The article so made is of very good value, and it is not likely that the changed name will greatly prejudice its consumption so long as the quality is maintained. There are low qualities which seem scarcely suitable for the use of man, but, on the other hand, there is butter placed on the market possessing the most objectionable smell and flavour, and the trade assure me that margarine, even of poor quality, can be sold more readily than such butter, because its flavour does not rapidly deteriorate. Instances have been known in different parts of the country of farmers buying this article to adulterate their own butter, the mixture being sold as genuine fresh butter. It readily lends itself for such an admixture, but such a trade is particularly immoral, and, when discovered, does more harm to the home dairy farmer than can be well imagined.

What has been said in this lecture respecting our butter supply may be thus summarised :—

1. Butter and butter substitutes are imported equivalent to the produce of not less than 1,400,000 cows, or 36 per cent. of the milch cows of the United Kingdom.

2. Our butter trade has diminished through want of uniformity in quality, and not being able to continue a regular supply in winter as well as in summer.

3. That individual effort cannot bring back our trade, but it must be done through some form of co-operative combination, as in France.

4. That skill must be brought to bear on the feeding of cattle, the treatment of the milk and butter, and scrupulous care exercised to make up the butter for market in the most convenient and attractive manner.

5. That the skill required should be imparted at the expense of the Government through dairy schools and similar means, and that every effort should be made to carry out such methods of instruction as will in the cheapest and best way take the education to the farmer at his farm, as is done in Denmark, and not compel the farmer to leave home to be educated.

Miscellaneous.

THE ECONOMIC USES OF FLOWERS.

By P. L. Simmonds, F.L.S.

(Continued from p. 963.)

The flowers of *Hemerocallis graminea*, when dried, constitute one of the choicest delicacies of the Chinese kitchen. They are largely exported from the province of Shan Tung. The Chinese eat the young flowers of the plantain pickled in vinegar, and these are eaten also in India. The capers used at our tables are the flower-buds of *Capparis spinosa*, or of *Zygophyllum fabago*, which latter are occasionally substituted for real capers. The well-known spice, cloves, are merely the unexpanded flower-buds of *Caryophyllus aromaticus*.

The crimson dye obtained from the large deep orange flowers of safflower (*Carthamus tinctorius*) are well known in this country in the form of small round flat cakes. Safflower contains two pigment principles, which made it in former years an important dye-stuff, much used for dyeing silks at Lyons. The petals yield a beautiful dye of various shades of colour between red and yellow. The "pink saucers" sold contain carthamine, and this, mixed with powdered mica or talc, forms the rouge used by ladies. Chinese safflower is most esteemed, but India used to grow large quantities, the best coming from Dacca. Ten years ago the exports from India exceeded 32,000 cwt., besides that locally used; now the exports have dwindled down to 1,000 or 2,000 cwt., the trade having been killed by the aniline dyes. It is much to be regretted that the beautiful vegetable dyes used by the natives are now almost superseded by the coal tar colours. A few Indian princes have indeed tried, by prohibitory duties, to prevent their introduction into the States over which they have control.

The dried flowers of *Butea frondosa* and *B. superba*, known under the several names of dhak, tisso, toolsee, and kassaree, are extensively used in India for the production of beautiful yellow and orange dyes, and have been imported into this country. They grow in clusters of large orange-red flowers, which by simply pressing them when fresh, or boiling or steeping them, if dried, in a weak solution of lime in water, produce a beautiful colour. Under the name of suringee and nagkassar the

flower beds of *Calysaccion longifolium*, which resemble a clove, are collected in India for dyeing yellow. The blossoms of a larkspur furnish a yellow dye in Korassan. The white fragrant flowers of the malapoo (*Cedrela Toona*) also yield a yellow colour by boiling in water, which is used for dyeing women's clothes and men's turbans.

The *Sophora japonica* is cultivated in all the eastern provinces of China for the sake of the imperial yellow dye obtained from its bunches of flowers and undeveloped flower buds. They are gathered, separated from the calyx, and dried in the sun. The handsome yellow flowers of the marigold (*Calendula officinalis*) also furnish a dye. In India the flowers are made into garlands for their idols and for the decoration of houses in festivities.

A species of camomile is grown in France for the sake of the brilliant yellow dye obtained from it, and the *Genista tinctoria*, known as dyer's weed, also yields a yellow colour.

The red flowers of the *Hibiscus rosa-sinensis*) supply a red dye, and have been used to polish boots and shoes. They are given in the East as an offering to the Goddess of Energy. The flowers of dhai (*Woodfordia floribunda*) yield a red dye, used in colouring cotton, silk, and leather.

The flowers of the harsinghar (*Nyctanthes arbor tristis*), on boiling, yield in India beautiful but fleeting orange or buff dye, extracted from the corolla tubes. The flowers fall in numbers towards morning, and are collected either for the dye they yield, or to string in necklaces for native women. The flowers are simply dried and kept in that state till they are needed for dyeing purposes. The flowers of the teak tree (*Tectona grandis*) are used in parts of India for dyeing red, and so are the beautiful flowers of *Punica granatum*. The orange flowers of *Abutilon spicatum* seem also to be in use in India for dye purposes.

The dried stigmas of the crocus are of importance for saffron, which has been highly prized from a remote period as a condiment, perfume, and dye. Ii is largely produced in France and other parts of Europe, and is also grown in Asia, China, Japan, and Tunis. The pistils are the only productive part of the flower, the rest being waste, and of these it takes about 70,000 to produce a pound of saffron. It is used for colouring and flavouring food, and even for dyeing morocco leather, but the price is too high to admit of its extensive use as a dye. About 219 cwt., valued at £58,000, are imported annually into India. Cake saffron is made of the florets pressed together with mucilage. As a medicine, in small doses, saffron is considered stomachic, and is prescribed in fevers, in large doses it stimulates the nervous system. A species of saffron, the produce of *Lyperia crocea*, is obtained from the Cape Colony.

Some flowers attract birds and bees by their nectar, others repel them by their stupifying odour. The insect powder of commerce consists of the florets of the disk of different species of *Pyrethrum*, collected before the seed is fully formed. The flowers of tansy are also said to have this stupefying effect on insects. The Caucasian and Persian flowers, locally known as "guirila," although at first employed for insect powder, are no longer of commercial importance. The cultivation of these flowers is now chiefly carried on in Dalmatia and Montenegro, and the trade centres in Trieste, where some 12,000 cwt. are sold yearly at the price of about £11 a cwt. The unground flowers are much preferred, as the powder is greatly adulterated. From one Russian port, Poti, this insect powder used to be exported to the value of £7,000 a year.

A considerable trade is carried on in what are known as "immortelles," or everlasting flowers, species of *Gnaphalium* and *Elichrysum*. These are made into garlands, crosses, and other devices, to decorate the tombs of deceased relatives and friends in cemeteries.

Passing now to the medicinal uses of flowers, we have first the strobiles or female flowers of the hop plant, which are valuable for their aromatic, tonic, and narcotic properties. The damask roses are grown for medicinal purposes. Before the bud is about to open the bottom, or "keel," as it is termed, is cut off, and the top dried and preserved, to make either infusion or conserve of roses. The Provence rose (*R. gallica*) is reported to be astringent.

The flowers of the hollyhock are mucilaginous and demulcent, and those of the marshmallow (*Malva sylvestris*) are much used in France, under the name of "Guimave."

The red flowers of *Grislea tomentosa* are considered an astringent tonic. In medicine we have also "Balaustines," the flower of the pomegranate.

The properties of camomile flowers have long been known to medical science. They are an exceedingly useful and cheap stomachic tonic in dyspepsia, and an anodyne. The single flowers are more odoriferous than the double ones, and yield a larger proportion of volatile oil.

An infusion of linden flowers (*Tilia Europæa*), drank as a tea, is reported to be a cure in chronic epilepsy. They are used in France in the form of a *tisane*, and the distilled water is considered anti-spasmodic. The flowers of *Hibiscus rosa-sinensis*, are emollient, and an infusion of the petals is given as a demulcent. Kousso, the flowers of *Brayera anthelmintica*, of Abyssinia, and the flower heads of *Artemisia*, act as vermifuges.

Violets are considered purgative, but a conserve of the flowers with sugar has a grateful flavour for covering nauseous medicines. In Turkey a sherbet is made of this violet conserve.

Flowers, as we have seen, are employed in medicine, but they are also used in some instances as food. It is rarely that we find the corolla of a plant serving any other purpose than as a temporary protection for the reproductive organs within. But for a flower to secrete more than half its weight in sugar, and thus become an article of important economic value, is most remarkable. Of this we have an instance in the

flowers of an Indian tree, the Mohwa (*Bassia latifolia*). fleshy, snow-white flowers are produced in enormous quantities in March and April. They fall off and cover the ground beneath the trees, and are gathered eagerly by the natives during the flowering season, and eaten either raw or cooked.

A single tree will yield many hundredweights of corollas. These are eaten, as a rule, once or twice a day by the poorer classes of the wild tribes of Central India, and in parts of Bombay, Rajpootana, and Bengal. In Monghyr, south of the Ganges, there are about 1,000,000 of these trees, so that the yield of flowers there annually cannot be far short of 100,000 tons. The ripe flowers have a sickly smell and a sweet taste, resembling manna. They are stored as a staple of food by many tribes. When dried they have somewhat the odour and appearance of Sultana raisins. Containing $63\frac{1}{2}$ per cent. of sugar, one-seventh of which is crystallisable, they are as nourishing as grain, but people could not live on them alone for any length of time. After being sun-dried, the flowers are prepared for eating, by being heated over a fire in an earthen vessel for a quarter of an hour, during which they are stirred with a stick to prevent burning. The flowers are sometimes bruised and boiled to a jelly, and made into small balls, and are also put into sweetmeats. The flowers are distilled by the Parsees, and yield a powerful, coarse spirit. Large quantities of the flowers were shipped to Europe a few years ago for distillation. Their commercial value in India is about 12s. to 16s. per cwt.

Cowslip flowers, fermented with sugar, form a domestic wine, and are also used for a balsamic drink, known as paigle tea. The dried blossoms communicate an aromatic fragrance to home-made wines resembling Muscatel.

The flowers of meadow sweet (*Spiræa ulmaria*) are also used by wine merchants to improve the flavour of home-made wines, and they also yield a fragrant, distilled water.

Some of the Chinese teas, as orange pekoe, and caper, are often scented with flowers. The petals of the sweet-flowering olive were formerly used for this purpose. Now the *Jasminum Sambac*, the Chu-lan (*Chloranthus inconspicuus*), and *Gardenia florida* are chiefly employed. One process is to take the tea hot from the last roasting, put a layer of it into a chest, and strew a handful or more of the flowers over it; this is done continuously until the chest is full; it is then closed, and thus remains for twenty-four hours. The proportion of flowers is about 5 per cent. to that of tea. The tea and flowers thus mingled are put into a hour-glass-shaped basket, the sieve containing them resting on the centre contracted part, so as to keep it well away from the fire. After roasting in this way two or three hours, the flowers are sifted and winnowed, and the tea thus scented will impart sufficient flavour to ten times its own bulk. It is therefore mixed accordingly, and is generally put for a moment or two into a slightly-heated pan, previous to packing. Another mode is to dry the petals over a slow fire, and then pound them, sifting the powder over the leaves during the last two dryings.

Traces of these have often been found in black teas here; the Chu-lan flowers, which are green, turning almost white when seared, and looking like so much fine sawdust. A third method is by putting a sieve of the flowers under another containing the tea in the basket, and letting the fumes of the one ascend into the other. The first process described is, however, that most prevalent.

PROGRESS OF THE GERMAN COLONIAL POSSESSIONS.

Consul-General Raine, of Berlin, in his last report, says that the colonial policy of the German Empire is slowly but steadily realised. Cameroons, for instance, exported, in 1886, 1,924 tons of palm-nut oil, 1,697 tons of palm-nut kernels, 6,536 kilogrammes of caoutchouc, 8,372 kilogrammes of ivory, and 1,521 kilogrammes of cocoa. As regards the revenue and expenditure, official figures show for the former 167,000 marks, and for the latter 178,000 marks, a deficiency of 11,000 marks; for the Tago land, 76,000 marks revenue and 94,000 marks expenditure, a deficit of 18,000 marks. In these two German protectorates an order has been issued for the imposition of import duties on ardent spirits. The late Reichstag appropriates a subsidy of 150,000 marks for the encouragement of scientific pursuits towards the opening and exploration of Central Africa. The New Guinea Company received, by Imperial ordinance of July 20th, 1887, the right to acquire and encumber real estate. One of their expeditions has, it has been stated, been crowned with complete success. Numerous harbours have been discovered, and it was found that the Augusta River opened a clear route into the interior. It is considered a good field for establishing a German colony. The country is said to be rich in minerals; even gold has been found in several places, as has been the case lately also in "Luderitz Land" (Angra Pequena, South-West Africa, on the Swakop River, about 70 miles from the Walfish Bay). The German West African Company has, since the beginning of 1887, purchased goods of a total value of 100,000 marks, intended for West African trade. About 100 German firms have been engaged in the delivery of these goods, sent out with the company's first expedition in March, 1887. The total inventory of the company represents a value of 180,000 marks, inclusive of 80,000 marks for buildings, slaughter-houses, apparatus, machines, tools, freight trucks, draught oxen, horses, boats, &c. All sorts of trades and professions are engaged. A soap and candle factory is to be established; glue-boiling works, fishing and whale catching, and a raw india-rubber factory are also contemplated. A guano

factory is already in full operation. Of the East African Company, according to the last report, their stations have not yet been permanently established, but steps have been taken to erect buildings. There are at present 13 of such stations, which in the first place are to serve for agricultural and trading purposes, and secondly, for administrative and political ends. Six of them may be regarded as plantations proper—three on the Kinparu (Dunda, Madimole, Hongula), one in Pengam, one in Kingaru (Usanbarra), and one in Petershöhe. The stations Upnaprova (Usegara) and Anisila (Kilima-Ndscharo) are intended for cattle breeding and colonisation. At the Kingaru station about 100 morgen (the morgen being equivalent to eight-ninths of an acre) of forest have been cut and cleared, and here European vegetables of all descriptions have been grown, also maize, rice, bananas, vanilla, tobacco, cotton, &c. There are stations where about 300 native labourers work per day at monthly wages of from nine to ten marks. These are said to be quick in comprehension, and are expected before long to be able to acquire the art of cultivation. The South American Colonisation Company of Leipzic has acquired large tracts of arable land in Paraguay, and intends to settle industrious German colonists, and invest sufficient capital to make a profitable living for many thousands of Germans.

RAILWAY COMMUNICATION IN SICILY.

The railway system in Sicily, so necessary to the development of the resources of the island, makes slow progress. There are still, according to Consul Stigand, of Palermo, important towns, numbering 40,000 inhabitants, in the interior and on the coast, which are only accessible by the vehicles provided by the post, or in private carriages. The chief line which now awaits completion is that from Messina to Palermo, which has received the sanction of the Government. This line offers great difficulties of construction for a great part of its length; long tunnels and deep cuttings being necessary. Immediately on leaving Messina, a long tunnel, called the "Galleria Peloritana," has to be made, which has been in progress for some months. The line is, at present, open from Palermo to Cefalu, but on leaving Cefalu another considerable tunnel will also have to be made. The portions of the line of easier construction have been considerably advanced, especially that from Messina to Milazzo. The port and district of Milazzo, and in fact the whole line from Messina to Milazzo, is expected to profit greatly by the establishment of railway communication. The port is perhaps the most thriving in Sicily, and the whole track from Messina to Milazzo is very fertile in fruit, oil, and wine, and the completion of the line from Milazzo to Palermo is of primary importance for the development of the resources of the island. Other lines in the interior of the island are also much called for. The line from Palermo to Corleone, which had stopped running, has again been opened, and it is projected to carry it right across the island. Another project which has received Government approval is that of the "Siracusa-Noto" line, which is to unite Syracuse to Licata, passing through Noto, Spaccaforno, Modica, Ragusa, Vittoria, and Terranova. This line is to be 133 miles in length, and will unite some of the principal towns and small ports on the south-east coast. Of this line only 20 miles have been opened, that is from Syracuse to Noto. The town of Caltagirone, which is one of the most prosperous and advanced in Italy, still remains outside the network of railway communication. This it is proposed to remedy by a railway from Valsavoja, near Catania, to Caltagirone, a distance of 40 miles. Along the south and south-western coasts operations for laying down rails are shortly expected to be commenced. Consul Stigand says that if Mazzara, Castelvetrano, Sciacca, and Girgenti were joined to Licata, and a branch were opened up to Bivona, and if the Palermo-Corleone Railway were carried on to Bisacquino, Chiusa, and Sciacca, the natural resources of Sicily would sooner or later find proper vent.

General Notes.

Grants to Dairy Schools.—It is announced that the Lords of the Committee of Council for Agriculture have awarded the following sums out of the £5,000 granted by the Government for the present financial year in aid of agricultural and dairy schools, viz.:—The Cheshire County Dairy School, £150; Aspatria (Agricultural) School, £250; Edinburgh University, £300; Glasgow and West of Scotland Technical College, £200; Kirkcudbright Dairy Association, £70; Ayrshire Dairy Association, £125; Wigtownshire Dairy Association, £101 10s.; and to Dumfriesshire Dairy Association, £28 10s.

Inland Navigation Congress at Frankfort.—An International Congress of Inland Navigation will be held at Frankfort-on-the-Main, next week, the members being officially received at the Palmen-Garten, on the evening of the 19th. Papers will be read by Mr. Lindley, Engineer-in-Chief of Frankfort; M. A. Gobert, Ingénieur Honoraire des Ponts et Chaussées of Belgium, and others; and various excursions will be made, including a visit to the works now in progress for canalising the Main, and making Frankfort an inland port. M. Gobert is taking a party of engineers, including several specialists, from Brussels to Frankfort, as far as possible, by water, the various steamboat companies offering every facility.

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FRIDAY, AUGUST 24, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

Prizes are offered to Art-workmen in the following classes:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5; second prize, £2.
   b. Shaved or turned, first prize, £5; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.
   c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for the outside of a window, for a street-door panel, or for indoor use as a window screen, coil case, ventilator, &c.

IV. Goldsmiths' and Silversmiths' Work.

[Prizes presented by the Goldsmiths' Company.]

A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First Prize £20; Second Prize £5.

A pendant or brooch, or locket of gold without gems. First Prize £20; Second Prize, £5.

All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered have appeared in previous numbers of the *Journal*.* They can also be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

OUR MILK, BUTTER, AND CHEESE SUPPLY.

By Richard Bannister, F.I.C., F.C.S.

Lecture III.—Delivered April 23, 1888.

Our Cheese Supply.

We have seen that we are largely dependent upon other countries for our supply of butter, which is of a perishable nature, and suffers from keeping. It consequently follows that cheese, which is more stable in composition than butter, and has to be kept for ripening, will be imported from an extended area of supply, either when new or in different stages of ripening. The soft cheese, chiefly of French manufacture, is almost as delicate as butter, but the different kinds in general consumption can be moved without difficulty,

* See *Journal*, June 15.

TABLE XVIII.—IMPORTS OF CHEESE.

Year.	From United States.		From Other Countries.		Total Quantity.	Total Value.
	Cwts.	Value.	Cwts.	Value.		
		£		£	Cwts.	£
1859* ..	60,998	155,792	345,549	883,388	406,547	1,039,180
1860....	187,450	532,443	395,833	1,065,126	583,283	1,597,569
1861....	323,461	741,802	382,934	894,997	706,395	1,636,799
1862....	365,500	768,823	338,409	781,348	703,909	1,550,171
1863....	383,821	925,007	372,464	961,880	756,285	1,886,887
1864....	466,988	1,213,890	367,856	962,358	834,844	2,176,248
1865....	442,913	1,296,204	410,364	1,167,095	853,277	2,463,299
1866....	415,726	1,386,447	456,616	1,415,132	872,342	2,801,579
1867....	526,740	1,470,017	378,736	1,085,248	905,476	2,555,265
1868....	489,117	1,439,380	384,260	1,125,833	873,377	2,565,213
1869....	487,870	1,612,325	491,319	1,471,525	979,189	3,083,850
1870....	555,385	1,861,263	485,896	1,313,068	1,041,281	3,174,331
1871....	731,326	2,014,805	485,074	1,326,691	1,216,400	3,341,496
1872....	598,198	1,701,435	459,685	1,329,532	1,057,883	3,030,967
1873....	790,238	2,353,181	566,490	1,708,275	1,356,728	4,061,456
1874....	849,933	2,589,776	635,332	1,894,151	1,485,265	4,483,927
1875....	958,978	2,786,027	668,770	1,923,481	1,627,748	4,709,508
1876....	936,203	2,564,977	595,001	1,672,786	1,531,204	4,237,763
1877....	1,082,844	3,129,829	571,076	1,641,564	1,653,920	4,771,393
1878....	1,345,745	3,306,612	623,114	1,630,074	1,968,859	4,936,686
1879....	1,214,959	2,467,651	574,762	1,356,366	1,789,721	3,824,017
1880....	1,171,498	3,411,625	604,499	1,679,889	1,775,997	5,091,514
1881....	1,244,419	3,555,702	595,671	1,689,413	1,840,090	5,245,115
1882....	969,502	2,711,259	725,121	2,038,611	1,694,623	4,749,870
1883....	990,963	2,695,704	808,741	2,194,696	1,799,704	4,890,400
1884....	976,190	2,479,908	940,949	2,521,727	1,917,139	5,001,635
1885....	844,205	1,865,164	989,627	2,204,180	1,833,832	4,069,344
1886....	856,109	1,837,487	878,781	3,033,872	1,734,890	4,871,359
1887....	759,463	1,847,412	1,075,004	2,661,525	1,834,467	4,508,937

* Duty of 1s. 6d. per cwt. British produce, and 2s. 6d. per cwt. on Foreign. Free in following years.

and are imported accordingly in different stages of ripeness.

In 1859, there was a small import duty on foreign cheese, and Table XVIII. (p. 1002), shows the changes in our imports which have taken place from that year down to the present time. The Table is divided into two parts, giving the quantity sent to us from the United States and other countries respectively. Fluctuations in these supplies have in certain years been very violent, but from the United States there was a steady increase from 1860 to 1881. In the following year there was a falling off of upwards of 270,000 cwts., and last year there was a further diminution in supply of 485,000 cwts., as compared with 1881. From a further inspection of the Table, it will be seen that these fluctuations do not apply to the total quantities imported, as, with three exceptions only, the quantity of cheese imported last year was larger than during the twenty-seven years the free importation of cheese has been permitted.

The countries of origin from which the cheese was imported last year were:—

	Cwts.
United States	759,463
Canada	631,837
Holland	362,014
France	30,260
Other countries	50,893
	1,834,467

Canada has become famous as a cheese-producing country, and with a sparse population and abundance of suitable land for dairy purposes, it was fully expected that cheese-making would become a general industry in the districts suitable for the purpose. Last year, the 1,391,300 cwts. sent to this country from America, Canada produced 45·4 per cent., and the United States 54·6 per cent. of it. In 1860, the total quantity of cheese imported represented $2\frac{3}{10}$ lbs. per head of the population, and in 1887 $5\frac{5}{8}$ lbs. per head. The declared value per cwt. was £2 14s. 9d. in the former, and £2 9s. in the latter year.

The description of cheese imported from America is Cheddar, or Cheddar loaves. This cheese is dry, and fairly tough and hard, and as a Cheddar cheese weighs about 70 lbs. it is very suitable for being produced at large dairies, or in cheese factories.

Dutch and French cheese are fairly uniform in character, but during the last ten years the soft descriptions of French cheese have become more in demand, till at last, on account of the profit made on these descriptions of cheese, our farmers are trying to make them at home.

American and Canadian producers are, at the present time, benefiting by the low ocean freights. In February of this year, the cost of freight from New York to Liverpool in line steamers was, for cheese, 4·80 dollars a ton, and for butter 6 dollars, which is equivalent to one penny for 10 lbs. of cheese, and the same sum for 8 lbs. of butter. Freight is, therefore, nominal only, for higher rates than these are charged for the ordinary carriage of butter and cheese from one district to another in Great Britain. These countries, although thousands of miles away, are consequently very close to us in cheese competition; the telegraph commanding the market, and the steamers bringing the cheese in excellent condition, to be stored here till required.

The quantity of cheese exported, and of butter also, is only nominal, as will be seen from Table XIX. (p. 1004); it has therefore been excluded in computing the quantity of cheese imported per head of the population, although, if included, the increase would have appeared somewhat larger.

It has frequently been said that the importation of hard cheese has been due to the falling off in quality of our Cheddar, Gloucester, and Cheshire cheeses, which, at one time, were in great demand on account of their superior quality. Such statements are made, generally, by the somewhat large class of persons who consider the past always better than the present, but these assertions are practically without foundation, the milk in these districts not being now so generally made into cheese, on account of the demand for it in the adjacent towns. The fact is, there is as good cheese made in these old districts as ever there was, but, with facilities for cheap locomotion, people travel more than they did, and are more critical with regard to their food and drink, requiring a more variable and enlarged dietary. If the whole of the milk yielded by the milch cows of Somerset, Gloucester, and Cheshire were converted into cheese, the quantity made would, approximately, be:—

			Cwts.
Cheshire	103,587	milch cows producing	414,348
Gloucester	42,795	,, ,,	171,180
Somerset	110,735	,, ,,	442,940
Total	257,117		1,028,468

or 362,832 cwts. less than was imported last year from America.

It is frequently overlooked altogether that

TABLE XIX.—EXPORTS OF BUTTER AND CHEESE.

Year.	Butter.		Cheese.		Total Value.
	Quantity.	Value.	Quantity.	Value.	
	Cwts	£	Cwts.	£	£
1859*	139,768	719,993	34,428	137,478	857,471
1860...	125,352	637,925	28,700	120,068	757,993
1861...	96,969	466,679	31,[illegible]24	130,577	597,256
1862...	80,594	374,174	32,320	126,766	500,940
1863...	102,607	471,849	41,031	157,520	629,369
1864...	67,634	326,928	36,563	147,251	474,179
1865...	64,333	333,228	27,190	111,702	444,930
1866...	67,015	360,810	38,028	164,972	525,782
1867...	55,414	266,270	29,798	127,746	394,016
1868...	53,[illegible]59	272,530	25,264	103,401	375,931
1869...	51,130	270,366	25,684	109,943	380,309
1870...	57,528	315,826	25,194	110,246	426,072
1871...	56,322	327,431	22,441	96,138	423,569
1872...	54,454	305,570	19,440	82,392	387,962
1873...	44,961	265,585	18,786	81,063	346,648
1874...	42,668	259,331	18,689	81,553	340,884
1875...	39,265	240,281	21,332	88,143	328,424
1876...	33,749	211,439	17,411	70,230	281,669
1877...	37,385	247,033	16,755	69,698	316,731
1878...	36,766	243,144	16,530	66,009	309,153
1879...	36,677	235,506	14,231	55,140	290,646
1880...	31,408	201,671	11,963	50,634	252,305
1881...	32,945	205,153	12,378	51,208	256,361
1882...	21,640	219,726	16,149	65,443	285,169
1883...	30,408	212,214	13,984	58,839	271,053
1884...	28,895	202,523	14,447	60,733	26[illegible],256
1885...	28,692	175,646	12,708	51,928	227,574
1886...	29,225	165,070	12,922	51,157	216,227
1887...	27,634	155,901	14,328	56,730	212,631

* Following years duty free.

whilst our population is increasing, our agricultural productive power is diminishing, on account of land going out of pasture for building purposes, and in such circumstances we must, as a matter of course, become more dependent on foreign supplies. Every year the food to be made up from foreign sources steadily increases, and when freights are low, foreign produce of equal quality with our own can in many instances be sold cheaper, on account of the prevalence of lower rents, and consequent diminished cost of production.

The following summary, though not absolutely correct, is sufficiently so for showing our position with regard to our milk, butter, and cheese supply:—

Cows in milk in Great Britain and Ireland	3,928,267
Cows required to supply butter equivalent to the butter and butter substitutes imported	1,387,000
Cows required to supply the cheese imported	455,034
Total cows required	5,770,301
Increased number required	1,842,034

Increase 46 9 per cent.

It is evident from the above figures that, unless the cows were made to yield more milk, it would be impossible to find pasture for such an increased number. That cows can, by judicious feeding, be made to give an increased quantity of milk of good quality, has been proved by experiment both at home and abroad. From a series of trials made on Lord Vernon's herd at Sudbury, it was shown that by carefully noting the chemical composition of what was required for a perfect food for dairy cows, the cost of it could be reduced from 10s. 8d. to 6s. 7½d. per week per cow, without any diminution in the quantity or quality of the milk supply, and by proper feeding the quantity of the milk can also be very largely increased. An average cow will yield about 420 gallons of milk a year, but by careful selection and good feeding the following quantities have been obtained:—Mr. Tisdall's herd of 25 cows, year's average 885 gallons; Mr. Tisdall's herd of 10 heifers, year's average 858 gallons: Mr. Welford's herd of 12 cows, year's average, 700 gallons; Mr. Barter's, of Cork, herd of 20 cows, year's average 682 gallons; Mr. McAdam's herd of 64 cows, year's average 634 gallons; a Danish herd of 220 cows, year's average 641 gallons; and individual cows have reached a maximum yield of 1,300 gallons a year.

It will be apparent that the benefits of this knowledge of food and yield are chiefly confined to those who either sell milk as such, or butter. For such large milk production the cows must be kept up as a rule, consequently it would not be prudent or practicable for the cheese farmer to keep his cows under such special conditions as to food and shelter. It is known to dairy farmers that all cows are not equally suitable for butter-making, although the quantity of milk yielded may be the same, but this fact is intensified in cheese-making, and cows, food, and pasture have to be put on their trial. Cows for cheese-making must not be fed on artificial food, on account of

the flavour such food will give to the cheese, and the herbage of certain lands will act similarly; consequently, in almost every district, the farms which will produce the best cheese are known and properly appreciated.

Old grass pasture, which is not manured by artificial manure, is the best, and it should be kept for cows only. A Cheddar farmer affirmed that he could tell from the flavour of his cheese whether sheep had run with the cows at the time the cheese was made; and although such a statement may be considered hypercritical, it is notorious that artificial flavours and keeping qualities are more pronounced in cheese than butter. As artificial manure is now much used, it is likely that our cheese has locally suffered in quality from such a cause; but, beyond such accidents, the cheese now made is, as previously stated, as good as it ever was. An accident illustrating the ease with which hurtful flavour can be imparted to cheese happened at the Cheshire Dairy School last year. Through giving the cows silage which had not properly fermented, the cheese made during the period had such an objectionable flavour as to be unmarketable.

The milk best suited for ordinary cheese-making is that which is rich in casein or curd, and poor in fat; in fact, abundance of fat in slow ripening cheese is objectionable, and rich milk is frequently deprived of a portion of cream to make the cheese stand and ripen properly. Reverting to the Table showing the the composition of cows' milk, it will be observed that in different samples the

		Per cent.
Fatty per centage was 2·76, 2·43, 3·33, 3·76, 6·79	average	3·81
Casein or curd was 3·05, 2·96, 3·18, 3·50, 3·31	,,	3·20
Together		7·01

Cheese should consist solely of these two constituents, the fat and casein; and if any quantity of serum or whey is left in the cheese, trouble will certainly ensue, on account of the sugar present in it. The lactic, butyric, and other ferments will be present, and these, under suitable conditions, are sure to decompose the sugar, and cause the cheese to heave, and become porous and strong in flavour. The modern methods of curd crushing, where speed rather than thoroughness is the worker's aim, are a fruitful source of imperfect separation of serum, and the different conditions of the cheese produced at the same factory when cut, and the many distinctive flavours the different cheeses possess, indicate that much has yet to be learned in cheese-making. The ferments named are all useful in developing cheese flavour, but they must be controlled, or damage will be wrought. If any or all of these ferments are permitted to attack milk, it soon becomes sour, or so decomposed as to be unfit for food. Their presence, therefore, in milk is highly objectionable as well as unnecessary. It may be repeated that milk taken in a fresh state by the weakest stomach is first curdled, but the juices of the stomach so modify the solubility of its most insoluble portions, that it is at length in a condition to be assimilated by the weakest digestion, and thus becomes the natural food of the young of all mammals. In cheesemaking, these changes are wrought in another way, by adding the active agent in the stomach to the milk itself.

Cheese, as before stated, consists of the casein of the milk and the fat also, which is carried down with it in the act of separation from the serum. This separation might be affected by acids or by the lactic ferment, but if either were used difficulties would occur in manufacturing the curd so separated, and the finished article would not be commercial cheese. The separator used from time immemorial has been the fourth stomach of the young calf, which, under the name of rennet, is a well-known article of commerce. The calf whose stomach is most active for the purpose is one which has had no other food than milk. The stomach must be carefully cured and preserved, and without fully recording the methods of curing in use, it is essential that it be kept sound and free from all other taints except its own. The quantity used should be carefully noted, because too much makes the curd leathery, and too little causes the curd to separate too slowly, and to be in hand too long. In large dairies and factories it is a general practice to use a special preparation of rennet, or to make one from home-cured skins. In either case there is greater likelihood of securing uniformity than at small farmhouses, where one cheese is made every day, or every other day, and the rennet has to be kept long in use.

The curd, when separated by rennet, always contains more or less ferment, which it gets from the air; but the rennet itself does not acidify the milk, although the presence of acid causes it to act more quickly. These ferments are developed by the after treatment, and it is on account of their presence that the casein steadily undergoes changes by becoming more soluble and modified in character. These

changes can be measured by the flavour, odour, and physical appearance of the cheese when ready or ripe for consumption.

In some descriptions of cheese, the modifications thus effected give to them their distinctive characteristics of quality and flavour; but with other descriptions their ripening is more or less dependent on the action of foreign organisms, in the shape of mould spores or other bodies; and therefore such cheese can only be prepared in districts where these organisms abound, and that, too, at the proper temperature for their natural development and growth. Consequently, cheese so made, and possessing the necessary character and flavour, cannot be produced at will in a new district without taking proper precautions, and those precautions are that properly-ripened cheese from an old district shall be brought in contact with the cheese the subject of the experiment, and thus the matured cheese is made to supply the organisms required. To illustrate this point, I may mention that a farmer who had devoted much time to the manufacture of a special soft cheese could not get the necessary flavour and condition of the foreign-made cheese. Time and labour were spent in vain, till on one occasion, after comparing the foreign and home-made cheese, he was called away hurriedly, and left the cheeses in contact. He saw a change in the ripening of his cheese, and guessing the reason, from what he had read and heard, he tried the experiment of putting the foreign cheese side by side with his own. The result has been that he is now able to make the cheese without difficulty, as his factory contains the organisms necessary to do their part at the proper time. Cheshire, Stilton, Gorgonzola, and Roquefort are familiar illustrations of the same facts, the last not only being matured in a special place, but has in manufacture an artificial ferment added to it, to give it the special characteristics of porosity, moisture, maturity, and ramification of mould throughout the entire mass which these cheeses possess when fit for consumption.

Unfortunately, the life histories of the different micro-organisms attacking cheese cannot be readily worked out on account of their number and small size; but the changes they effect are quite apparent to smell and taste, even when the most delicate chemical experiments are at fault in making any appreciable difference in the composition of ripe and unripe cheese. The difficulties connected with the study of bacteriology are, however, being rapidly overcome, and the impetus given to this branch of science by the researches of Professor Koch and others, has directed many able workers to this new field of discovery. Many mistakes have already been made, and theories have been propounded which have been based only on half truths; but progress has been, nevertheless, made, and methods of pure cultivation of bacteria have been devised which leave little to be desired on the score of simplicity. The main inducement to study in this field is the connexion which has been shown between infectious diseases and bacteria, and Pasteur, Hanson, and others have already included animal and vegetable products in their investitions, whilst another class of investigators has made plain the functions bacteria serve in the economy of nature in destroying putrefactive animal matters.

The effect of the addition of rennet to milk is to make the casein, which really is not in solution in the milk, apparently insoluble. The coagulation thus taking place when the milk is sound and good enables the operator to have the curd under complete control, and it has been already pointed out that the quantity of rennet added limits the intensity of such separation. The time required for curd separation is from forty to sixty minutes, and the exact moment for completing the operation must be decided by the condition of elasticity of the curd for the particular kind of cheese to be made. The serum or whey cannot be got out of the curd except by cutting it, and as the greatest care has to be exercised to retain the fat, which is locked in the curd mechanically, suitable appliances are used for such a delicate operation. At this stage very serious mistakes are often made; the curd may be cut contrary to its grain, or it may be so tough that the serum cannot be got out of it; for unless the whey is properly separated in the cheese-pan, it cannot be removed by pressure afterwards.

The temperature at which the milk is set, and the treatment of the curd in the cheese-pan, regulate the after development of the curd; and when treating of the manufacture of different descriptions of cheese, it will be made apparent how important these two points are. Another point relied upon for separating whey from the curd is the development of acid in the curd. In the sweet milk, or Staffordshire and Derbyshire systems, this is not done during the separation and breaking of the curd, but afterwards; whilst in the Cheddar and Cheshire systems the acid is distinctly developed by special treatment, which treatment will be explained in its proper place. This development of acid

has an intimate connection with the ripening of cheese, and in some large dairies or factories the cheese made at the commencement of the season is made more acid than that made later on, to ripen it sooner for the market. It will be self-evident that cheese so made must, at the proper time, be put into consumption, or it will not remain sound; but this cannot always be arranged, and then there is a heavy loss, as well as disappointment to the maker. This is the reason why cheese is so frequently put on the market in bad condition, and the price realised for it is so small and unremunerative. Salting is relied on for controlling the amount of acidity, but fat cheese does not readily take salt, while skim-milk cheese, like lean meat, absorbs it readily.

The ripening of cheese is also to be carefully attended to. Temperature and moisture must be carefully studied in the cheese room, and upon them mainly depends the time taken to mature the cheese, and the flavour and texture it shall possess when cured. Uniformity of temperature is a necessity, and stoves should not find a place in the cheese-room, on account of making the atmosphere too dry. The cheese, under these conditions, would dry too quickly, and the casein would not be mellowed sufficiently in consequence. During the process of drying, a chemical change is taking place in the casein, and this is accelerated or retarded by the conditions under which the cheese is dried. An irregular temperature in the drying-room gives the cheese a bitter flavour, and, therefore draughts and chills are to be avoided, while every care should be taken that the cheese is regularly turned, to secure uniformity in moisture. A thermometer (self-registering) should always be kept in the cheese-room, the temperature should be duly recorded and kept for reference, and uniformity of temperature secured by having hot-water pipes all round the walls. not in one place only. The different modifications of flavours, texture, &c., of different kinds of cheese entering into consumption may, perhaps, best be treated when the method of making the different kinds of cheese is being described.

The composition of natural cheese, as sold to the consumer, is given in the following Table:—

TABLE XX.—Analysis of Commercial Cheese.

Description.	100 parts contain—					Salt per cent. in Cheese.	Per-centage Composition of Fat.		Weight of Cheese.
	Water.	Fat.	Casein or Nitrogenous Matter.	Free Acid as Lactic.	Ash.		Insoluble Acids.	Soluble Acids.	
									lbs.
Cheddar	35·60	31·57	28·16	0·45	4·22	1·43	88·75	4·55	70
American Red	28·63	38·24	29·64	—	3·49	0·72	89·06	4·26	63
American White	31·55	35·93	28·83	0·27	3·42	0·82	88·49	4·81	69
Gloucester	35 75	28·35	31·10	0·31	4·49	1·28	85·29	6·68	Single 17; Double 28
Gruyère	33·66	30·69	30·67	0·27	4·71	0·81	88·97	4·41	168
Dutch	41·30	22·78	28·25	0·57	7·20	4·45	87·58	5·84	4
Cheshire	37·11	30·68	26·93	0·86	4·42	1·69	87·76	5·55	57
Stilton	23·57	39·13	32·55	1·24	3·51	0·67	88·96	4·42	16
Gorgonzola	31·85	34·34	27·88	1·35	4·58	2·11	89·18	4·40	16
Roquefort	32·26	34·38	27·16	1·32	4·88	3·04	88·70	4·91	4

A careful examination of the foregoing figures will throw considerable light on the maturing of cheese. It will be observed that the five first in the Table contain very little acid, the American, Gloucester, and Gruyère being particularly low. The Dutch, which evidently has not been made from whole milk, contains more, but the Cheshire, Stilton, Gorgonzola, and Roquefort contain apparently excessive quantities. In the manufacture of the six first the serum or whey is separated by pressure only, the Cheshire and Stilton varie-

ties are deprived of it partly by heat and partly by pressure, and the two last depend for their maturing on foreign organisms. To those acquainted with the characteristic properties of these descriptions of cheese, it is well known that their consistence and texture can be easily classified, the four last being not so solid as the others, and when ripe are richer in moulds, whose mycelium seems to penetrate the mass. The Gorgonzola and Roquefort are particularly rich in this respect, and when these two are made microscopic objects, it is at once seen that the bulk of the cheese is honeycombed with vegetable organisms. The looseness of texture of the curd has evidently facilitated the penetration of the moulds, and it will be observed by comparison that the moulds have modified the consistence of the body of the cheese, making it more or less salvy, according to the quantity and character of the different organisms present.

Cheddar cheese is perhaps the best known cheese in the world. Large in size, sound in texture, and fairly dry at all times, it can be manufactured in large dairies in any part of the world, and transported without risk or difficulty to the place of consumption, It matures slowly, but when ripe and well made it has the finest of flavours, and is the greatest favourite with the masses. The Cheddar system of cheesemaking, whilst at one time confined to Cheddar and the surrounding district, is now in general use where large cheeses are made, and it lends itself particularly for factory purposes and for very large dairies where much milk has to be converted into cheese. This cheese has in its own district been historically famous for more than 200 years, and at the earliest times it appears to have been made of very large size. Evidently it must have been produced by associated dairies, for the farms have been always comparatively small in the district, and unable to produce cheese of the size described. The present methods of Cheddar dairying owe much of their development and codification to Mr. Joseph Harding, of Marksbury. A pioneer in dairy education, he was at all times anxious to impart his knowledge to others. He leaned to the notion that a good dairyman could make the same quality of cheese anywhere, and once said, "Cheese is not made in the field, or in the byre, or even in the cow, it is made in the dairy." Care evidently does very much in securing success, especially when working upon large quantities of milk, and through attention to the smallest details in the pasture and dairy Mr. Harding achieved much of his success. The Americans copied from him, and our present dependence on the American cheese market for our supplies affords the best proof that they have not copied in vain.

Mr. Harding's method of making cheese was to set the milk at a temperature of 80° F. in a milk tub which could be artificially heated. As soon as the curd broke, it and the whey were raised to a temperature of from 95° to 100° Fahr. This operation hardened the curd and separated the whey. During the heating the curd was stirred by a blunt instrument, and when this was over the whey was separated whilst sweet. The curd was then allowed to stand, to develop acid, and when drained from the whey and cooled, was broken and ground. Whilst being ground, it was mixed with salt in the proportion of one pound to every 56 gallons of milk. The cheese was then put in press, and in a day or two bandaged. Mr. Harding observed that newly-made Cheddars gave out moisture at the rate of 2 lbs. per ton every 24 hours, and he used this fact to hasten or retard evaporation in the curing-room when the temperature was lower or higher. He could thus regulate artificial temperature, and he produced some of the best Cheddar cheese ever made.

The lessons he taught American agriculturists were not thrown away, as before stated, and having the raw material of cattle and land at command, it has been justly said of the United States that "the dairy business of this country has developed with such rapidity, and to such a degree of importance, with the aid of the highest intelligence and the application of the most consummate skill, as to be regarded as one of the highest triumphs of modern agriculture." The States in which dairying is chiefly carried on are New York, Ohio, Pennsylvania, and Vermont, the first-named being specially famous for the manufacture of cheese and butter. In 1831, the first shipment of cheese was made to Great Britain, but the quality was bad through faulty manufacture. Associated dairies have now almost superseded private enterprise, and the ease with which good grazing land could be acquired enabled each associated dairy to become a centre, and to work up the milk of from 300 to 400 cows fed on the surrounding farms. The average size of farms in New York and Ohio is about 105 acres, and in some adjoining States the average is less. During the last 15 years, American cheese manufacture has greatly increased, on account of the prejudice being overcome

against cheese and butter made from prairie-fed cattle. Twenty years ago, prairie-fed butter was classed as grease, but now the true value of such butter and cheese are acknowledged, and the North-Western States have become producers both of butter and cheese. Difficulties respecting the water supply have been successfully overcome, the windmill having been pressed into service for pumping water from the wells sunk for supplying the cattle. The growth of large towns, such as Chicago, has had a marked effect in promoting and stimulating this industry, and now, from one cause or another, dairy farming has become general through all the States suited by climate and pasture for milch cattle.

Canada, or rather that part of it bordering the United States which is suitable for dairy farming, has made great progress in cheese-making, as will be apparent from figures which will presently be supplied, as well as from the Table before given, showing the quantity of cheese imported from Canada to this country last year. In 1857-8-9 the exports of cheese from Canada amounted to 124, 117, and 323 cwts., and the imports in 1859 and 1864 were 7,660 and 6,665 cwts. respectively. In 1879-80 the quantity exported was nearly 400,000 cwts. In 1864 and 1866 cheese factories were first established in Ontario, and at the present time there are more than five hundred in this province alone. In 1880, one gentleman, Mr. D. M. Macpherson, ran thirteen factories, his operations covering an area of about eighteen miles square, and he utilised the milk of 4,000 cows. By this system of concentration of management a uniform standard of quality is secured, this want of uniformity having previously been felt as the only defect in the Ontario cheese manufacturing system. Mr. Macpherson speaks in favour of having one practical person to manage several factories rather than managing each factory separately, and he considers this system of management as great an improvement on the ordinary factory system as the factory is on the private dairy. This system of combination is not confined to Ontario, for in Western New York persons own from two to twenty factories each, and concentration seems to be the order of the day. Such immense combinations can scarcely be understood on this side of the water, but a crumb of comfort can be picked up for our dairy farmers from the results of the competition at the International Dairy Show at New York in 1878, when cheese from England and from every cheese-producing State in the United States and Canada was exhibited. The first prize was given to three Cheddars from Bath, and the second to three Canadian-made Cheddars. The progress made, however, both in Canada and the States affords ample proof that carefully made factory cheese will be superior to the cheese of any English district when made at different farms in different ways.

Important and powerful as the system of associated dairying has become, it is of very modern growth, and commenced only in the year 1851. Another system of co-operation had existed before, viz., the collection of the curd from different farms into a central factory, but the collection of milk for cheese making in a properly appointed factory dates from 1851. In that year Jesse Williams, of Oneida County, New York, contracted to sell his cheese of the following season to certain dealers, for consignment to Liverpool. The deal was so satisfactory, that next year his son's cheese was included in the contract. The quality, however, was not so good as the father's, and as the son could not do better, the father received the milk, and made it into cheese with his own. This answered, and next year the Williams' factory commenced operation, the milk from 360 cows being used; 70 of which belonged to the Williams' family, and 290 to other farmers.

The strides made in factory dairying have been already dwelt upon, but it may be of service to classify the dairies thus:—

1. Purely co-operative, where farmers run their cows together, and are governed by defined rules for their share in the profits.

2. Associated dairying; where the factory is erected by the associated dairymen, and the net proceeds divided in proportion to the milk supplied.

3. Private enterprise; where the raw material is bought from the farmer as merchandise, the proprietor of the factory taking all risk.

The last-named is generally the most successful, as the proprietor has only to consider his own interests, and can drive the hardest bargains with the producer.

The factory-made cheese produced in June, July, and August generally does not stand well. It goes off in flavour, does not long remain sound, and is known in the market as "hot weather" cheese. This deterioration is mainly caused by want of cleanliness in the factory. The hot weather is a fruitful cause of acid milk, and it is not uncommon, in the hottest part of summer, to have in factories

most offensive smells, which are indicative of putrefactive fermentation. Want of cleanliness is the main cause of these ills, and this chiefly arises from allowing milk or its products to lie on the floor and get sour. A dairy floor cannot be kept too dry and sweet, but there is great labour in effecting this satisfactorily. On account of the serious losses occurring every year from this cause, efforts have been made to produce cheese made from sour milk which shall be free from taint. It has been seriously stated that this can be done by the oxidation of the curd, and that it is practicable to make from unsound materials cheese possessing proper flavour and character. This oxidation is brought about by putting the curd on a rack and exposing it all to the air by constant stirring. The advantages claimed are that volatile oils giving the taint are dissipated, whilst the flavour of certain fixed oils is developed in an unusual degree. The new system aims at simple chemical changes, by breaking up old combinations and forming new ones, and the two agents relied upon to work this change are rennet and oxygen. The function of the rennet is to destroy the cohesive power of the casein, and so to disintegrate it that it may never intimately combine with the compounds referred to. The rennet action should keep pace with the oxidation, and the skilful cheesemaker's duty is to discover the exact point when perfection is reached; then stop the digestive (rennet) action and oxidation, and thus secure to the cheese the maximum of flavour, digestiveness, and nutrition. Hot weather cheese has, however, its offensive unsound qualities still, and as the oxidation system has for nearly ten years been before the public, it is evident that it does not answer in practice, although from a theoretical point much may be said in favour of the ingenious views put forward by its advocates.

Cheese containing large quantities of fat is difficult to manage, and in America, where butter commands a comparatively high price, it has for some years past been the practice to skim off a certain quantity of cream, and use this partly skimmed milk for cheesemaking. Cheese and butter factories are, therefore, found together, in fact the latter flourish at the expense of the former. The morality of this system has been frequently called in question; but as the cheese and butter so made give a better return on capital than if cheese only were manufactured, the system of making partially skimmed milk cheese, and selling it as whole milk cheese, will continue. Butter continues to be largely made in private dairies in the States and Canada, and is, therefore, produced over a larger area than cheese, as it can be made in very small quantities.

The concentration of cheese-making in certain districts has led to combinations of cheese producers for the purpose of assisting each other in protecting their industry, and enabling them to sell their cheese at the least inconvenience. In this country markets and fairs are used for the sale of cheese, but in the States, in the cheese centres, men have combined in different ways for a like object. Local markets have been established in certain districts, but in the cheese centres certain days of the week were at first set apart for buying and selling. Then one day only was used for the purpose, and the prices obtained were officially printed and circulated. Afterwards, in such centres as Little Falls and Utica, where the same description of cheese was produced, it was suggested that "Dairy Boards" should be established, to supervise the commercial aspects of the trade, and to act as a chamber of commerce. This has been done. The associations consist of members admitted by subscription, and who must be producers, factory agents, or dealers. Sale rooms for transaction of business are provided, but sales must take place on certain market days only. There is a register kept of buyers and sellers, a Board of arbitration for the settlement of disputes between buyers and sellers, a committee to grade qualities, and all other things necessary to inspire confidence in the *bonâ fides* of all concerned.

The cheese made at the different factories is so uniform that purchases from each factory are made on sample borings, and in some cases samples are not produced at all. The cheese is removed by railway to its place of destination, and in very hot weather the railway trucks containing it are cooled by ice to avoid damage, and this is also done with milk and butter.

English cheese factors have their agents in America, who make themselves thoroughly acquainted with the quality of cheese made at the different factories. The selections they make are usually collected at a central warehouse, and there the special mark of the importing firm is put on, to do away with all risk of the dealer or consumer on this side learning at what factory or district the cheese is made. The importer, and not the manufacturer, thus becomes known, and the English factor secures

for himself a reputation for the brands he imports.

The factory system in this country has never been a great success, and the increased demand for milk has stood in the way of progress. Agricultural depression has compelled the farmer to turn over his capital in the quickest manner, and he has therefore sold milk where practicable instead of turning it into cheese.

Twenty years ago, an effort was made to start a factory near Derby, and the Duke of Devonshire, with other enlightened landowners and farmers, met together to put their ideas into practice. From factory dairying they looked for the following advantages:—

1. Greater uniformity in the quality of the cheese.

2. Enhancement of value in dairies which, from poor plant and absence of good accommodation, are now producing inferior cheese.

3. The removal of an arduous occupation, frequently deterring men of capital—owing to domestic considerations—from entering upon farms on which cheese-making is a prominent feature.

4. Improvement in the value of land from improvement in the value of produce.

5. The general introduction of system, better plant, skill, and supervision.

The idea was new both to farmer and cheese factor, and knowing the prejudice to novelties, the promoters proposed that a guarantee fund should be established to secure those farmers against loss who supplied milk. This was done, and a factory, rent free, was established in Derby for commencing operations, and steam was supplied free of cost from a silk factory adjoining.

A dairyman was obtained from the United States, and the work commenced. A second factory in connection with the first was established at Longford, and these two were known as the Derbyshire Cheese Factory Association. Cheddar cheese was made, but when ready for market the cheese factors would not buy it, because they thought the co-operative system was against their interests. Hitherto they had frequently acted as bankers to the farmers, and they considered that if cheese were made in factories instead of by private individuals, they would lose their business. The cheese was sold, however, but from a variety of causes the factory was not a success, the principal one, in my opinion, being want of cleanliness. Others have since that time been started in different districts, but although some of them are still in work, there are none which can show a good balance-sheet.

An effort is now being made to start dairy associations which shall be educational establishments for the young farmers, dairymaids, and others interested in dairy management. Factories started on such lines will prove decidedly beneficial to those whose good is sought, and it is likely that the promised Government aid may be applied to foster such really technical education, and for founding a prize fund for those who excel at the examinations. More emulation and zeal may be infused into the management than could be commanded in the factory, and having Denmark, the United States, and Canada as patterns in dairy progress, it may be that, by education and imitation, our dairy industry may be improved. We may thus be able to feed cows cheaper, to obtain more milk from them, to make butter as good as any foreign brand—and that, too, all the year round—and to produce cheese which, however much it may vary in form and size, may prove to be the best of its kind, and each class of uniform quality. The competitions at our agricultural shows in butter-making and other practical dairy work are invaluable, and the interest taken in them give very distinct indications of progress. Great improvements in cheese-making are, however, not to be looked for, the quantity made is comparatively small, and it is questionable whether, in the face of foreign competition with low freights and other facilities of locomotion, the British farmer can compete for general custom, although in certain districts home-made cheese will always be appreciated very highly.

The manufacture of Cheddar cheese has been treated as fully as space will admit on account of its extension to America, and the large quantities made there both for home consumption and for export. Other kinds of cheese made here, however, have a general reputation, and of the descriptions of cheese made without heat which are worthy of notice may be mentioned the Gloucester and Wiltshire cheese.

The Gloucester is a type of the Leicestershire, Derbyshire, and Staffordshire sweet curd cheese, and the remarks applying to it are equally applicable to them.

The Gloucester cheese, from its difference in size, is known as the single and double Gloucester. The former weighs about 17 lbs., and is two or three inches thick; the latter is about 28 lbs. in weight, and four or five inches

thick; it is generally made twice a day, the temperature at which the milk is set being 85° Fahr. The curd is collected with the utmost care, in fact, cleanliness is the characteristic of every dairy operation, and as the cheese is allowed to ripen slowly, it is expensive to make, but when made properly, and matured perfectly, it is an excellent mild cheese. The drawback to it is that is generally very highly coloured, and about a month after the cheese is taken from press, each is painted with harmless colours, as Indian red or Spanish brown. The colouring of cheese is a decided mistake, as, in the eyes of the consumer, the colouring of the cheese is thought to be intended to cover some defect in appearance or structure. This prejudice against colouring matter is not confined to cheese, for brown brandy, brown sherry, and other coloured drinks and foods are looked upon with suspicion, and the demand for them, in consequence, is small. The Gloucester cheese possesses a mild flavour, being not pronounced in any direction, and it is a well-prepared sound cheese, favourably known outside its district of production.

The Wiltshire cheese is not now so well known to the London consumer as it used to be. It is not a whole-milk cheese, the evening's milk being generally allowed to stand for the night, to be deprived of its cream in the morning, and then the skimmed milk is mixed with the morning meal. It is generally set at 80° Fahr., and the curd and whey are heated, as in the Cheddar system, to about 90°-95° Fahr. The curd is then pressed for about half-an-hour, and taken out and ground. About 2 per cent. of salt is added to the curd when being put in vat; it is then pressed, and occasionally rubbed with dry salt. After being kept in press a week, it is left to ripen in the cheese room. Its flavour is mild; but other descriptions of cheese have taken its place in public estimation, and the Wiltshire dairyman has consequently been driven out of the cheese market by competition and change of fashion.

The cheese of Cheshire is supposed to owe its excellence to geological as well as other causes. The geological formation of the county is principally new red sandstone and boulder clay, and as it has immense salt deposits, the herbage produced is supposed to be eminently suited for cheese production. Be this as it may, Cheshire has been for many years famous as a cheese-producing country, and at the present time the cheese is in good demand. Its method of manufacture is a distinct departure from what has been hitherto described, and heat as well as pressure is used for the separation of the serum. The milk is set with rennet at about 78° to 82° F, and the curd is first treated as in the manufacture of sweet curd cheese. It is afterwards drained on racks, to develop acid as in the making of Cheddar; the curd is afterwards ground and mixed with salt. It is then put in vats perforated like those used for Stilton cheese, packed loosely in the vat and kept at a temperature of from 70° to 80°. The whey is drawn out through the holes in the vat, and the cheese is afterwards put in press, where it may remain a week, but is turned and attended to daily. When removed from press the cheese is washed with warm water, greased to prevent cracking, and swathed in stout bandages. The cheese is afterwards put in a heated room, and is more slowly or quickly ripened according to treatment.

When a ripe Cheshire cheese is cut, it will present a peculiar appearance as compared with a Cheddar. Mould will have greatly developed, and from the patches of mould inwards the cheese will appear to have lost some of its artificial colouring. This is due to the spreading of the mycelium of the fungus, which has found its way through the loose texture of the cheese, and has largely contributed to the flavour, character, and moisture possessed by the cheese. Sometimes the cheese put on the market is not satisfactory, but, as before explained, this is generally caused by the development of acid for premature ripening. Such cheese is right enough if eaten when in condition, but it will not keep, and soon develops flavours which seriously deteriorate its value, and compel the maker to sell it when ripe at whatever price it may command.

The Stilton cheese is one that possesses a very high reputation, and when compared with the cheese before enumerated, commands a high price. On account of its method of manufacture it is tender and brittle, and bears carriage badly, but from its size and form it can be eaten without much waste, and is a favourite cheese on festive occasions. It can only be made in perfection from cows which graze on old pasture lands not artificially manured, and which produce grasses free from any distinctive flavour. The grazing land of Leicestershire exactly fulfils these conditions, and there the cheese is chiefly made.

It came into notice in the following simple way about 100 years ago. Stilton was on the coach road from London to Edinburgh, and at

the "Bell" Inn in this village the proprietor supplied his guests with cream cheese of particularly fine quality. The desire of the passengers to obtain this cheese for home consumption was gratified by Mrs. Paulet, the maker of it, and she used to sell it at half-a-crown a pound. The demand which arose for it soon commanded a more extended supply, and the villages round Stilton, and notably Dalby and the Melton Mowbray district, became famed for Stilton cheese. It now finds its way to London, chiefly near Christmas time, and with the turkey and the barrel of natives it shares the honour of being frequently made a Christmas present. If, however, the modern method of making is compared with the recipe used in Mrs. Paulet's day, it must be evident that the Stilton of to-day is very different from its namesake of 100 years ago. Then we are told marigold flowers contributed to its colour, and a gallon of water containing the marigold juice was added to "the milk of seven cows and the cream of the same number." Then rennet was added. The curd was put into a sieve to drain, then put into a cloth, when cold water was poured on it to cover it. Then after standing half an hour, half the curd was put into a vat six inches deep, the top of the curd being broken to enable the other half to unite; then the other half was put to it, and half a hundredweight was laid on it. It had then to stand half an hour, then be turned and put in press, and turned into clean cloths *every hour the day it was made.* The next morning it had to be salted, and then let be in salt a night and a day, then it was swathed tight till it began to dry and coat, and was kept covered with a dry cloth a great while. The best time to make this cheese was said to be in August.

Mr. Jubal Webb's modern method is different in many particulars from the foregoing. He says the cows should be milked regularly, and the night's milk should be put into a "lead" to stand all night. To the morning's milk in the cheese pan should be put the cream of the night's milk, and when stirred up together, and at a temperature of 83° Fahr., rennet should be added. In one hour afterwards the curd is broken up very little, left to stand ten minutes, and then put into "leads" with cloth strainers to allow the serum to drain off gradually. The curd is then very slightly pressed, put into a tin strainer, and left till fit for putting into hoops. When put into hoops, the curd is broken smaller, and in the hoops is first put a layer of curd, then a sprinkling of salt, and so on till the hoop is full of curd. The salt must not touch the ends of the hoop. The hoop of curd is put on the shelf of the drainer on clean dry cloths, and is turned up and down three or four times a day. When the curd becomes compact, it can then be taken out of the hoop, and the time taken may vary from four to twenty days. The cheese when taken from the hoops is strongly bound in linen cloths, which at first are changed three or four times a day till the cheese ceases to stick to the cloths. When the cheeses are dry enough, the binders can be taken off, and they are then transferred to the cheese-room, where they are at first turned twice and then afterwards once a day. After a time the cheese-mite makes its appearance, when each cheese should be brushed daily, and changed from shelf to shelf. "The brushing opens the pores of the cheese, and admits the air, thus promoting the development of the fungus called blue mould, which is so highly prized in Stilton cheese." To develop the blue mould it is a practice with some makers to insert with a cheese-borer bits of cheese covered with blue mould, but this is not at all necessary if proper time is taken for ripening.

The foregoing details of Stilton cheese-making illustrate how very lightly the cheese is put together as curd, and explains how it is that Stilton cheese has always a very loose texture. It is evident that loose packing and fungus development play a very important part in ripening the cheese. To show this more fully, I will take out of their ordinary turn Gorgonzola and Roquefort, and thus complete the series of cheese which are mainly dependent upon foreign organisms for their flavour and appearance as matured cheese.

In making Gorgonzola, which is an Italian cheese, the milk is set warm, and immediately after it has been taken from the cow. The curd is at first slightly broken, and afterwards systematically divided by a wooden tool, and which is always moved in one direction. The curd, when more solid, is cut into squares, and allowed to drain through a cloth. When the curd is put in the vat it is mixed with curd kept from the previous day, a layer of new, and one of old, the top and bottom layers always consisting of fresh curd. The vats, or forms, are then covered up for a time, afterwards the top of the cheese is crumbled for access of air, and then turned upside down. This operation is repeated, and the day after the cheese is made it is taken into a room

whose temperature ranges from 65° to 70°, and placed on a layer of straw; here the cheese is frequently turned, then specially salted, put in and out of the vats many times, according to system, and then kept in a dampish cellar, where it is wiped and got ready for the market. The blue mould permeates the cheese, and the moulding is hastened by frequently piercing the cheese with skewers, whose indentations are easily traced when the cheese is cut for sale. The acid introduced with the old curd speedily ripens the cheese, and the change thus effected causes the cheese to be very tender, and liable to rapidly decompose if not eaten when just ripe. The flavour is excellent, but more salvy than Stilton.

The Roquefort cheese, which of late years has risen in public favour, is made in one district in France from ewes' milk. The industry is an old one, the production being estimated as follows:—

In 1800	the cheese	made was	250,000	kilos
1830	,,	,,	300,000	,,
1840	,,	,,	750,000	,,
1850	,,	,,	1,400,000	,,
1860	,,	,,	2,700,000	,,
1870	,,	,,	3,500,000	,,
1878	,,	,,	4,500,000	,,

The sheep are fed on the table-land of Larzac, where the grass is scanty, and the cheese, though made principally in the neighbourhood of Roquefort, is also produced in adjoining districts. The number of sheep kept is not less than 700,000, of which 450,000 are milking ewes. The sheep are milked twice a day. They belong to different farmers, and the cheese is generally made at the farms, although it must be matured in the natural caves of the district. The cheese is generally made in the morning, the evening's milk having been heated nearly to boiling, and afterwards placed in earthenware pots. The cream is taken off before the milk is added to the morning's meal. The mixed milk, after having been heated, is coagulated with rennet, and the curd, when cut, collected, and squeezed, is crumbled by hand. The vats for the curd are made of glazed earthenware, and are perforated; their diameter is about nine inches, and height four inches. Three layers of curd are put in each vat, and between these layers is sprinkled a specially prepared ferment, which is thus made. One part of wheat and two parts of barley are made into a paste, to which is added leaven and vinegar. The loaves, after they have been slowly baked, are kept in a warm place till very mouldy throughout. The crust is then removed, and the inside ground into a very fine powder. This powder, which is full of vegetable life, is sprinkled between the layers of curd, as stated. The curd, when placed in the vats, has a convex top, and by putting one vat on the top of another, pressure is applied till the tops are level with the vat. For some days the cheese in vat is placed in warmed wooden boxes, which are kept damp by the application of the steam of hot water. The cheese, before its removal into the caves, is dried for two or three days in an airy room, where it is frequently turned. The cheese is taken, in the coolest part of the day or night, into the caves, where the ripening is completed. These caves belong to a few persons who act as money lenders to the farmers, and apparently the most important owners of caves are a company called "The Society of United Caves," whose late manager, M. Etienne Coupiac, seems to have effected great reforms in the manufacture of Roquefort cheese. The temperature of the caves varies from 38° to 47°, and the caves are always in a humid condition from the water in them.

The cheese is first taken into the weighing room above the cave, then passed into the salting-room adjoining, where it is kept from four to six days. By this time the crust is almost vitreous, and must be removed. As each cheese does not weigh more than five pounds, it has been found a great saving of labour to do this work by machinery, and M. Coupiac invented a machine which is now in operation. Two brushes at one operation clean the upper and lower sides, and then, by a mechanical device, the cheese is carried onwards to a bed, where a circular brush cleans the circumference. The loss by hand labour varied from 20 to 25 per cent.; the machine has reduced this loss to a maximum of 18 per cent. In addition to this saving of labour, M. Coupiac invented a machine for hastening the ripening of the cheese. He was aware that the combined action of mould, damp, and cold air produced its characteristic condition and flavour, and he concluded that if each could be pierced throughout its substance, so that the air and mould could work more rapidly, the cheese would sooner ripen. He therefore constructed a machine of the size of the cheese, fitted with from 60 to 100 fine needles, and as each cheese is made to pass under the machine it is pierced by the needles. Twelve cheeses a minute can be thus perforated. The machine

has answered its purpose admirably, and the products of this society command the highest prices, their quality being uniformly good. The cheese is imported into England from February to May, and from September to the end of December. Every care has to be taken with it, as it is very tender and easily fractured, and to retard evaporation each cheese is covered with fine lead foil before being sent to this country. Its flavour is certainly delicious, and as it is in condition for a greater part of the year than Stilton it amply merits the popularity it enjoys.

Gruyère and Parmesan cheese demand special notice on account of their consumption in this country. The former is made in Switzerland and the latter in Italy, and from their size it is evident that they must be produced at associated dairies.

Gruyère cheese is generally made from whole sweet milk, and set at a temperature varying from 82° to 86° F. The curd is first cut and then broken with a curd breaker, and afterwards allowed to settle for ten minutes. The curd with the whey is then heated to a temperature of 140°, and the curd by this treatment becomes tough and hard. The curd, after the whey is pressed out, is put in vats and submitted to very heavy pressure. When this has been done it is looked over, dry clothed, and put into a cellar which is rather damp. It is systematically salted with dry salt, and when ready for consumption it is of close texture, except where the serum left in the curd has collected and formed a large hole. Its flavour is very characteristic, being mild and pleasant, and very uniform in quality.

Parmesan cheese is made very much after the same fashion as Gruyère, only the milk used is slightly acid. The curd is heated, and afterwards collected in a wooden vat without any pressure. It is salted and matured in the dairy cellar for about six weeks, then scraped, washed, and put in a drying-room; there it is turned and oiled systematically with linseed oil. This cheese should be kept three or four years before it is used, but the locking up of capital for so long a time generally compels the farmer to sell his produce to a factor for maturing.

As Dutch cheese is largely imported under the names of Gouda and Edam cheese, this industry demands attention. The toughness and compactness of the cheese affords evidence that the curd has been heated, and the low proportion of fat shows that the cheese is made chiefly from skim milk. In other respects the method of manufacture is much like our making up of sweet curd cheese, except that, for salting, the cheese is steeped in brine. During the process of ripening, the cheese is damped with warm whey, and in two or three months it is considered fit for consumption. The Edam cheese is made in a round vat, and before being sent away from the dairy, it is rubbed with linseed oil and coloured with a harmless dye.

The soft cheese consumed in this country has, till within the last few years, been chiefly manufactured in France. Home cheesemakers have, as before stated, become aware of the profits to be made out of cream cheese, and they have consequently turned their attention to the subject. We have now therefore several descriptions of home-made soft cheese commanding a ready sale, and only steady application of general principles of manufacture and ripening of cheese is required to produce soft cheese equally as good as most of that imported.

Camembert, Brie, and Neufchatel are the soft cheeses in most general demand, and all of them depend more for their flavour and character upon the ferments and moulds formed in the ripening cellars, than on any speciality in their manufacture. As before stated, good Camembert has been made here by the accidental bringing together of French matured cheese and cheese in process of manufacture, by which the moulds of the old cheese were transferred to the new, which required them for developing the characteristic flavour of commercial Camembert.

Of cheese adulteration very little need be said; it has always been particularly free from sophistication, and though there is a tendency at almost all farmhouses and dairies to take off a portion of cream for butter making, this practice can scarcely be deemed an adulteration. Colouring matter is sometimes used, but the fashion is quickly dying out, the public not being in favour of artificially coloured food. In the United States experiments were tried some years ago to prove whether animal fat might not be used in cheese as a substitute for butter fat, as in the manufacture of margarine. Cheese could be so made, but the "lard cheese" as it was called, was not appreciated, and gave no encouragement to a continuance of the manufacture. One cheese brought here for inspection this evening is a Danish "lard" cheese, taken from a consignment now in London, and offered at 36s. a cwt. Its appearance is fair, but it has a foreign flavour.

and from the difficulty experienced in selling it, even at so low a price, it is evident that "lard" cheese will not become an article of general consumption. Nor should it do so either, for both morality and commercial honesty revolt against the manufacture and sale of cheese containing any other than butter fat.

The composition of two cheeses containing foreign fat was as follows:—

TABLE XXI.—Composition of "Lard" Cheese.

100 Parts of Cheese Contained				Per Cent. of Salt.	100 Parts of Fat Contained		Melting Point of Fat.
Water.	Fat.	Casein and Free Acids.	Ash.		Insoluble Fatty Acids.	Soluble Fatty Acids.	
31·30	24·66	38·87	5·17	1·55	92·88	1·55	92° F.
30·95	28·80	36·27	3·98	1·14	92·43	2·16	77° F.

It will be at once apparent by comparing their composition with the genuine cheese given in a previous Table, that the fat present is not butter fat. The analyst can detect the fraud without any difficulty, and it is fortunate for the consumer that he can do so.

Cheese, whether made from whole or skim milk, is still commercial cheese, and, consequently, there can be no prosecutions for fat abstraction, although, in some instances, one cheese is far better in quality than another of the same kind. But the Food and Drugs Acts is not refined enough for such cases, and, therefore, the cheese-makers and dealers have not been troubled with the incidence of the Act.

In bringing this short series of lectures to a close, permit me to point out that on account of having to import so much dairy produce for our actual requirements cheese will, by its stability, always lend itself to the enterprise of the foreign producer. Canada has made rapid progress in cheese production, and New Zealand is commencing to make cheese and butter for export. Let us hope that our Colonies will be the successful competitors for the supply of what we actually need, and not strangers. But from what has been pointed out in these lectures, it is evident that we do not produce as much milk and milk products as we might do, and it only requires more knowledge of cattle feeding, and better methods of butter manufacture, to enable us to largely increase our milk and butter supply. We should then be in a position to produce more cheese for our own requirements, and it would then be practicable to place associated cheese factories on a better footing than they have ever been, so that cheese equal in quality to the best American brands could then be made at home. To accomplish this, technical education must be brought to the farmer at his own farm. He must there be taught what he may be expected to produce from the soil he has to cultivate, and then the theoretical instruction now given will be combined with and supplemented by practical knowledge. General knowledge of farming is of value, but the practical farmer wants a teacher acquainted with the capabilities of the particular district he farms, and agriculture cannot flourish till such teachers are provided throughout the United Kingdom.

Obituary.

W. Eassie, F.G.S.—Mr. William Eassie, the well-known sanitary engineer, died on Thursday, 16th inst., at his residence in King Henry's-road. He was born at Lochee, Forfar, in 1832, and his early life was chiefly devoted to engineering pursuits, when he became a favourite assistant to the late I. K. Brunel, and along with the late Dr. Parkes, F.R.S., he superintended the sanitary arrangements of Renkioi Hospital during the Crimean war. At the conclusion of hostilities he took a band of navvies and made the first excavations on the site of old Troy. In 1872 he published "Healthy Houses," and subsequently a work on "Sanitary Arrangements for Dwellings." He was honorary secretary of the Cremation Society, of which, in conjunction with Sir Henry Thompson and a few others, he was one of the founders in 1874, in which year he published his work on "Cremation of the Dead." He was elected a member of the Society of Arts in 1876, in which year he read a paper before the Society on "The So-called Deposits of Onyx near Mexico." In 1878 he read a paper on "The Systems of Cremation now in use on the Continent." He was a prominent member of the council of the Sanitary Institute of Great Britain and of its examination board until his decease, and was an honorary member or fellow of various learned societies on the Continent, especially of those dealing with matters of hygiene.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1889.

The subjects of examination are—1. Arithmetic; 2. English (including composition and correspondence, and précis writing); 3. Book-keeping; 4. Commercial Geography; 5. Shorthand; 6. French; 7. German; 8. Italian; 9. Spanish; 10. Portuguese; 11. Russian; 12. Danish; 13. Chinese; 14. Japanese; 15. Political Economy; 16. Domestic Economy; 17. Theory of Music; 18. Practice of Music; 19. Practical Commercial Knowledge.

These examinations will be held on April 8, 9, 10, and 11, with the exception of that in the Practice of Music, which will be held during the week commencing on the 20th May.

The Programme is now ready, and copies can be obtained gratis on application to the Secretary.

SOCIETY OF ARTS MEDALS.

The following bronze medals have been awarded by the Council of the Society of Arts, on the recommendation of the judges, to exhibitors at the Exhibition of Home Industries, held at the Crystal Palace by the Co-operative Union:—

Class.

I.—Engineering.—Thomas Coates, for model of steam fire-engine.

II.—Metal work, Art.—J. R. Stebbings, for specimens of chasing and embossing.

III.—Metal work, general.—Thomas Baker, for iron model of buoy and beacon.

IV.—Joinery.—H. E. Finn, for model of Thames pleasure skiff.

V.—Cabinet making.—Charles Cartwright, for brown oak sideboard.

VI.—Printing and lithography.—G. W. Jones, for specimens of letter-press printing.

VII.—Bookbinding.—Albert Marshall, for volume in green morocco.

VIII.—Watchmaking and jewellery.—A. W. Curzon, for marine chronometer.

IX.—House decorating.—James Edwards, for six decorated panels.

X.—Stone, wood, and other carving.—L. J. Perrin, for specimens of wood carving.

XI.—Leather work.—W. Bull, for leather opera and field-glass cases.

XII.—Bootmaking.—Austin Stretton, for pair of stitched gentleman's lace boots.

XIII.—Tailoring.—B. J. McCallan, for dress coat.

XIV.—Basket work.—Benjamin Shuckford, for bedroom linen basket.

RELATIVE ADVANTAGES OF THE RAILWAYS AND WATERWAYS OF GERMANY.

The last number of the *Journal of the Royal Statistical Society* contains a translation of an important paper on this subject by M. Todt of Cologne, taken from the *Bulletin du Ministère des Travaux Publics*. The following facts and opinions are extracted from the paper:—

Public opinion in Germany has for some considerable time been pre-occupied with the question of the favourable influence that might, from the point of view of the lowering of the prime cost and selling prices, be exercised by the development of navigable waterways. This question has to some extent forced itself upon public notice, and attracted general attention through the approaching execution of the works in connection with the canal from the Rhine to Ems, also of the canal from the North Sea to the Baltic, and the canalisation of the Spree. To these projected improvements, improvements which to some extent are actually decided upon, may be added many others, among them being the canalisation of the Moselle, the junction of the canal from the Rhine to the Meuse, the canalisation of the Ruhr, the lengthening up to Ruhrort and Duisburg of the canal from Ems to the Rhine, the deepening of the Rhine upward towards Cologne, the junction of this river with the Weser and the Elbe, and the improvement of the Oder between Cassel and the mouth of the Niesse. If these improvements were effectually carried out, they would constitute a kind of vast artificial network, over which goods would be transported at a much lower rate than they are at

present. The economy thus realised would inevitably tell upon the selling prices, and would open up new outlets for German products.

To the objection that the desired improvements would weigh very heavily upon the finances, at first by the interest and repayment of the capital engaged, and afterwards by the depreciation that the railways would suffer, the reply is made that the navigable ways would assure the development of the mineral and forest wealth now lying idle or insufficiently cultivated; moreover, it is urged that merchandise that could be carried by canals and rivers in preference to the railways are raw materials of small value, which, being carried at a low rate, do not constitute a remunerative traffic.

The following is an estimate of the quantity of goods carried over the German navigable ways in 1884:—Basin of East Prussia, Niemen, Vistula, Pregel, and Passarge, 2,227,000 tons; basin of the Oder, 861,000; basin of the Elbe, 7,767,000; basin of the Weser, 218,000; basin of the Ems, 176,000; basin of the Rhine, 7,565,000; Lake of Constance, 338,000; and the Danube, 210,000 tons, making in all, including the small coasting trade of Frisches and Curisches Hoff, a total of 19,362,000 tons.

Compared with the traffic on the Elbe and the Rhine, the movement upon the other waterways appears insignificant. The two first rivers absorb nearly nine-tenths of the trade, leaving to the others only about one-tenth of the total. It is only the rafts which are of any importance on the waterways of Eastern and Western Prussia. The Weser, Ems, and Danube hold the last rank. The movement of shipping is even relatively greater on the Lake of Constance than on these streams, but this may be accounted for by the fact that this lake constitutes, it may almost be said, an extension of the railways which abut upon it. Of the waterways of Eastern and Western Prussia, the Niemen and Vistula are the only ones the length of which is of any importance; but the misfortune is that the course of these streams in German territory is not a very extended one, and the foreign countries through which they flow are not sufficiently advanced, as regards their natural and industrial products, to justify them in devoting any considerable sums to the improvement and development of these ways of communication.

The traffic on the navigable streams of North Germany is of very much greater importance than that of South Germany, as the following Table will show:—

	Tons (including Rafts).
North Germany—	
Basins of the Niemen, Vistula, Passarge, and Pregel..	2,227,000
,, Oder	861,000
,, Elbe	7,767,000
,, Weser and Ems	394,000
Total	11,249,000
South Germany—	
Lake of Constance	338,000
Basin of the Danube	210,000
Total	548,000

The total weight of goods carried amounts to 16,500,000 tons for North Germany, and 3,000,000 tons for South Germany. If we compare East and West Germany, it will be found that the former has the predominance, thanks to the Elbe and to the waterways of East Prussia, the traffic amounting to 11,000,000 tons, while for the west, with the Rhine, Weser, Ems, Danube, and the Lake of Constance together, it does not exceed 8,500,000 tons. It is therefore the north-east district which holds the first rank, notwithstanding the fact that the chief river in Germany, the Rhine, belongs to the west.

The important part taken by North and East Germany in river and canal traffic is due to the greater development of the navigable ways in that flat region, where the waterways offer exceptional facilities for navigation, while the water courses of the south suffer the double disadvantages of too rapid descent and an insufficiency of depth.

The following statement shows in thousands of tons the traffic on the German railways in the year 1886:—

Coal and coke	51,888,	= 48·5	per cent.
Timber	6,220,	,, 5·8	,,
Stone	8,101,	,, 7·5	,,
Grain	6,704,	,, 6·2	,,
Minerals	4,376,	,, 4·0	,,
Iron	6,766,	,, 6·3	,,
Other metals	292,	,, 0·3	,,
Petroleum, oil, &c.	700,	,, 0·6	,,
Cement, lime, &c.	3,085,	,, 3·8	,,
Sugar, molasses, &c.	1,537,	,, 1·4	,,
Total	90,665,	,, 84·7	,,

The total weight of goods carried over the German railway system in 1884 amounted to 107,000,000 tons, or five and a half times more than the whole water carriage of the country.

Charles von Scherzer, in his work entitled the "Economic Life of Nations," gives as the total amount of traffic on the English waterways, the development of which does not exceed one-sixth of the railway system, a total of from 30,000,000 to 35,000,000 tons. For the United States the figure would be about 25,000,000 to 30,000,000, and for France about 20,000,000. A comparison therefore of the water and railway transports would be more favourable as regards the former in Germany than in England, and the actual result would be almost the same in France as in Germany. M. von Scherzer gives as the actual length of the navigable waters of England 2,980 miles, and the length of the French waterways as 2,794, the latter figure, however, does not not at all agree with the extent according to the *Guide Officiel de la Navigation Intérieure*, this publication giving the length of the rivers as 4,956 miles, and of the

canals 2,955 miles, making a total of 7,911 miles. As, however, M. von Scherzer's figures only relate to the waterways actually available for navigation, it is only necessary to take into consideration those rivers and canals in Germany which are regularly navigated. The length of these ways is about 2,484 miles, with a traffic of at least 18,000,000 tons. In England, therefore, there would be an average traffic of 9,662 tons per mile, in France 7,246 tons, and in Germany the same amount. In the latter country, 126,000,000 tons of merchandise are carried by water and rail, the proportion being 15·2 and 84·8 per cent. respectively, while a considerable part of the traffic has employed both methods of transport. This is particularly noticeable in the mining district of Ruhrort, towards the South of Germany, and it appears to be the general rule with the coal cargoes, exception being made of the Sarre coal, which is almost invariably shipped direct, without passing over the railway system.

It would be by no means an over-estimate to fix at from 8,000,000 to 9,000,000 of tons the traffic employing both water and rail. On the Rhine alone, over 5,000,000 tons of merchandise are carried in this way. A reference to the subjoined Table will show the distribution of the undermentioned articles over the railways and waterways, the articles in question representing a proportion of 83·3 per cent. of the transports by water, and 84·7 per cent. of those by rail.

Articles.	Total Quantity Carried.		Proportion to Total Traffic.		
	By Water.	By Rail.	Waterways.	Railways.	Total.
	Tons.	Tons.	Per cent.	Per cent.	Per cent.
Coal, coke, &c.	5,506,000	51,888,000	4·35	41·18	45·33
Timber	3,265,000	6,220,000	2·59	4·93	7·52
Stone	2,255,000	8,101,000	1·79	6·43	8·22
Grain, vegetables, &c.	1,993,000	6,704,000	1·58	5·32	6·90
Minerals	412,000	4,376,000	0·32	3·47	3·79
Iron and metals	635,000	7,058,000	0·50	5·60	6·10
Petroleum, oils, &c.	381,000	700,000	0·30	0·55	0·85
Cement, lime, &c.	1,065,000	4,085,000	0·84	3·24	4·08
Sugar and molasses	597,000	1,537,000	0·47	1·21	1·68
	16,110,000	90,669,000	12·74	71·93	84·67

The goods carried over the various railway systems, amounting in the aggregate to 107,000,000 tons, are distributed over a network of 22,000,000 miles, that is an average of 4,864 tons per mile. The traffic on the waterways, amounting to 19,000,000 tons, spread over an extent of 3,384 miles, gives an average of 5,623 tons per mile. Each ton of goods accomplishes, on an average, a journey of about 87 miles over the rails.

The following tabular statement shows a comparison of the two modes of transport for a certain number of principal cities :—

Cities.	Number of Inhabitants.	Goods carried.			Number of Tons per Head of Population.
		By Rail.	By Water.	Total.	
		Tons.	Tons.	Tons.	Tons.
Berlin	1,200,000	3,504,000	3,348,000	6,852,000	5·71
Breslau	270,000	1,237,000	350,000	1,587,000	5·88
Hamburg	410,000	1,191,000	3,221,000*	4,442,000	10·7
Magdeburg (including Buckau and Neustadt)	165,000	1,650,000	1,118,000	2,768,000	16·7
Dresden	220,000	1,411,000†	534,000	1,945,000	8·8
Bremen	112,000	776,000	184,000*	960,000	8·5
Ports of the Rhine (Ruhrort, Duisburg, and Hochfeld)	70,000	5,427,000	4,107,000	9,554,000	136·0
Cologne (including Deutz)	160,000	1,320,000	314,000	1,634,000	10·0
Mannheim and Ludwigshafen	75,000	1,776,000	2,041,000	3,817,000	50·0
Leipzig	160,000	1,675,000	..	1,675,000	10·0
Hanover (including Linden)	150,000	912,000	..	912,000	6·0
Munich	230,000	1,252,000	..	1,252,000	5·4

* Not including sea tonnage. † Exclusive of arrivals and departures by rail from Dresden to Breslau.

As a consequence of the comparison of the traffic by rail and water, it may be laid down as a general principle that there is no essential difference between the two modes of transport as regards the value of the articles carried. Both by rail and water, goods of small value preponderate, but this preponderance is much more marked on railways than on waterways. The latter are not limited in their choice of goods, as is generally supposed; soft goods in bales, and articles of value form no inconsiderable part of their transports. The traffic on the Rhine in grain, vegetables, flour, &c., in spite of the favourable conditions under which those goods are carried on German railways, increased from 156,000 tons in 1872, to 810,000 tons in 1883, thus following an ascending scale much more rapid than that which result normally from the increase of the population in the industrial centres traversed.

The increasingly important part taken by German navigable ways in the transport of merchandise is due partly to the action of the State, and partly to the natural causes of expansion. The action of the State has been manifested in two ways—by the execution of improvement in the waterways, and by the erection of ports and quays at the most important points. The many millions that the German States, commencing with Prussia, have devoted within the last fifty years to the improvement of rivers and streams have had a result, the more advantageous as various legislative measures have been passed with a view to lighten the burdens imposed upon river and canal navigation, amongst others, Article 54 of the Constitution, which removed the taxes hitherto levied upon the fleet for the interest and repayment of the capital engaged.

The employment of steam has in some measure been instrumental in regenerating the river and canal navigation. With the old sailing boats the average distance covered per diem was 19 miles at the most, taking into account the delays occasioned by contrary winds. The steam towage on the Rhine is effected at the rate of 3 miles an hour up and 6 miles down, or an average of $4\frac{1}{2}$ miles, making for a navigation of 15 hours $67\frac{1}{2}$ miles—that is, nearly four times the old speed. The steam carrier has a speed of 6 miles an hour up and 9 miles down, or an average of $7\frac{1}{2}$ miles. It covers a distance of from 112 to 124 miles per day. If the tug-boat be assimilated to a regular goods train, and the steam carrier to a direct goods train, it will be found that the speed at which inland navigation is effected is sensibly inferior to that of the railway. A goods train, even when heavily loaded, covers a distance of from 180 to 250 miles in 24 hours, while a direct goods train might even cover double this distance. As regards delays in the delivery of goods, canals and rivers compare very favourably with the railways. River navigation is concentrated on a certain number of ways, over which a heavy traffic passes, and is effected between a limited number of important ports, sufficiently distant one from the other. The river and canal navigation, moreover, is but little obliged to stop at night. It is far different with the railways. Even on those lines on which the traffic is heaviest account must be taken of the frequent stoppages at the intermediate stations, for loading and unloading goods, coupling or uncoupling trucks, changing engines or men, taking in coal or water, and shunting to allow passenger trains to pass. These different circumstances considerably lengthen the duration of the journey by rail. Transport by rail then as compared with that by water does not enjoy the advantage that the greater rapidity of traction would assure to it.

River and canal navigation offer three methods of transport with different rates, as follows:—(1) Transport by steam carriers; (2) transport in barges towed by steam; and (3) transport by sailing ships. The first is on an average from twice to four times dearer than the second; navigation by sailing ships is partly dearer and partly cheaper than towing. It becomes cheaper when it is a question of carrying down the rivers goods of little value, which have not to make long journeys; and that is because the use of steam would not prove sufficiently remunerative on account of the shortness of the distance to be traversed, of the current, and the inadequacy of the machinery for unloading. It is, on the other hand, dearer when navigation is effected up stream. As regards the second mode of transport, account must be taken of the composition of the train of barges, and the nature of the boats towed, their dimensions, and the nature of their construction, whether with or without decks, of iron or of wood. By reason of the guarantees of solidity and security afforded by their construction, iron vessels are able to command a higher rate of freight, and moreover they are better managed.

In spite of the statistics quoted, it is almost impossible not to recognise the fact that the general opinion as to the value of waterways as an instrument of wealth proceeds partly from erroneous ideas, and that the influence attributed to this mode of transport, not only from the point of view of the facilities accorded to national production, but also of the outlets open to commerce, is not always justified by facts. There is undoubtedly some show of reason in the numerous arguments at present put forward in favour of the advantages to be derived from the various canals, the execution of which is so anxiously demanded. The establishment of these new ways ought, we are told, to reduce the cost and selling prices to a rate impossible to be attained by the railways, and thereby would powerfully stimulate the national industry. Undoubtedly the canal from the Rhine to the Ems, with a junction to the canal from the North Sea to the Baltic, as well as the canal from the Oder to the Spree, would be productive of all the advantages attributed to it, and that even without detrimentally affecting the higher interests of the country. By the first of these ways the basin of the Ruhr would very speedily find the

facilities for placing goods on the German markets of the littoral, and also in the Russian and Scandinavian ports, and for export generally greatly increased. And, besides, all the operations of import and export, as regards the industries of the Ruhr, would be effected by German in preference to foreign ports. The canal from the Oder to the Spree, the national result of the improvement of the Oder, will give to the industries of Upper Silesia the navigable way of access to Berlin, the want of which has been so long felt.

The advantages anticipated from the establishment of a number of other ways are either insignificant or absolutely counterbalanced by serious economic disadvantages to such a degree, that one is forced to seriously inquire whether it is for the general interests that these works should be undertaken, and if undertaken, whether it should be with State aid. In this connection mention may be made of the canalisation of the Moselle, from Metz to its mouth, a canalisation ardently desired by those interested in the industries of the Ruhr. The work would have for its object the transformation of a river which suffers particularly from an insufficiency of water, and the rendering of it capable of accommodating the largest Rhine boats, even those with a burthen of 500 to 1,000 tons, and having a draught of from 5 to 6 feet. The transformation would be effected by the aid of important works, consisting principally of locks, in fact the proposal is to distribute 32 locks over a distance, in round numbers, of 200 miles. It would appear, however, that the hopes founded by the industries of the Ruhr upon the canalisation of the Moselle are illusory, and by reason of the doubtful success of the project, the Government would do well to seriously consider whether the national finances should be devoted to such an enterprise.

As regards the question of the importance of artificial waterways, there is very little doubt that as soon as these latter cease to be short links, intended to connnect between themselves the different systems of natural waterways, for example the junction of the Oder with the Havel and the Spree, but constitute important lines, with their own individuality, they cannot compete as regards the cheapness of transport with the natural waterways, even if the State be disposed to cover by the imposition of taxation the cost of maintenance. The natural lacuna in the matter of traffic by water would be less satisfactorily filled by the opening of an artificial way than by the establishment of a railway. Moreover, artificial ways have a much greater difficulty in adapting themselves to local circumstances. As a matter of fact, the principal sources of traffic, the industrial regions with their mines and minerals, are more frequently far from being favourable to the establishment on the spot of navigable ways. Traffic by water has therefore a natural propensity to concentrate itself in certain regions even more so than the traffic by rail.

To sum up, public opinion, in its infatuation for canals and improvements of natural waterways, does not take sufficiently into account the true influence that navigable ways may exercise upon the economic condition of the country. The happy effects that one has a right to expect from the opening of these ways upon the development of public prosperity, are frequently nullified by the obstacles placed in the way of the production of certain basins. It may be laid down, as a general rule, that it is rather importation than exportation that is benefited.

These two circumstances, properly appreciated, considerably diminish the economic value of a certain number of waterways, the execution of which appears to be so ardently desired.

ALIMENTARY AQUATIC PLANTS.

By P. L. Simmonds, F.L.S.

In the last number of the "Bulletin of the Paris Society of Acclimatisation," 5th August, an article appears on this subject, which merits attention from the novelty of the information furnished, and while drawing one or two items therefrom, I may add some supplementary detail which will be interesting. It will come as a surprise to many that in Asia and in parts of North America thousands of people feed on the farinaceous seeds of certain water plants. I do not here allude to the enormous crops of cultivated rice in Asia, nor to the wild rice (*Zizania aquatica*), or *fluitans* of America, but to the various water-lilies, the seeds of which are such a large source of subsistence to many. Firstly we have th species of *Trapa*, known in India under the name of "Singhara." This plant is also cultivated on a large scale in the lakes and rivers of Southern China.

Fortune thus describes it:—"Being detained for some time at Shanghai, I resolved to penetrate, if it were possible, into the district of Kwey-chow-foo. In ascending the river in a south-westerly direction, I soon arrived, after passing Kea-Hing-Fo, a city of 220,000 inhabitants, at an immense pool, which I suppose communicates with the celebrated Lake Tai-ko. The water, not deep, was covered with *Trapa bicornis*, which the Chinese call 'Ling,' the bizarre fruit of which, resembling a bullock's head with two horns, is highly esteemed in China. I noticed three very distinct varieties, one of which bore fruit of a fine red colour. Women and children in great numbers were paddling about in small boats of a circular form, like washing-tubs, collecting the seeds. Nothing could be more curious than these singular boats, large enough to contain the person and the product collected, and pushed about among the plants without injuring them. The sight of this immense number of individuals floating about in their little tubs in this swamp was to me most diverting."

Another voyager, M. Marchal de Lunéville, states, "The *Trapa bicornis* forms the food of the people when the rice crop is insufficient. The collection reminds me of the grape harvest in Europe. The 'Ling' is sown at the close of autumn, in those ponds where the water is shallow and clear, and in localities exposed to the south. The Chinese affirm that this culture absorbs the putrid emanations which rise to the surface of the stagnant waters. If the harvest is abundant the seeds are given to poultry, which fatten readily on them, and their flesh acquires an exquisite flavour. This water-chestnut, as it is termed, is considered refreshing and agreeable food in summer. In its green state it is sold in the markets of Pekin as nuts are in Europe. Dried and reduced to flour it makes a good gruel, and it may be mixed with flour for bread. Roasted or preserved in sugar or honey it is a pleasant food. It is also excellent food for geese, ducks, and other birds of the poultry yard."

The species which is cultivated in Kashmir, according to Roxburgh and Sir J. D. Hooker, is believed to be *Trapa bispinosa*, although usually stated to be *T. natans* and *T. bicornis*. It is met with from Central and Southern Asia (where it is called *Singhara*), to Ceylon and Japan, and also reaches in the south of Africa to Zambezi. To this species probably belongs *T. Cochinchinensis*, Lour.; and *T. incisa*, Seib. *T. natans* is said to have furnished a large part of their food to the ancient Thracians, in the same manner as *T. bispinosa* does at the present day to the inhabitants of Kashmir, and *T. bicornis* to the Chinese. It is mentioned by Dr. Royle that the former yielded as much as £12,000 a year of revenue to the Government of Runjet Singh, the tax being levied upon from 96,000 to 128,000 ass loads from the great Lake of Ooller.

In Kashmir, after a severe famine, the governor of the district in which is situated the Woos Lake, introduced the culture of the *Trapa*. This lake, which measures at least 5,000 acres, is so filled with this plant that navigation is impossible. The fruit is collected by entire boatloads, and the governor derives a large revenue from it. Many of these boats filled with the seeds arrive daily at Srinagar.

The seeds of the *Trapa bispinosa* and *T. natans* contain a great quantity of fecula, and are eaten by the natives. In Gujerat they form an important article of food. During the Hooly festival a red dye is made from the fruit, mixed with a yellow dye from the flowers of the *Butea frondosa*. Colonel Sleeman has given the following interesting account of this plant in his "Travels in the South-Western Provinces":—"Here, as in most other parts of India, the tanks get spoiled by the water chestnut (*Singhara*), which is everywhere as regularly planted and cultivated in fields under a large surface of water as wheat or barley is on the dry plains. It is cultivated by a class of men called Dheemurs, who are everywhere fishermen and palankin bearers, and they keep boats for the planting, weeding, and gathering of the *Singhara*. The holdings or tenements of each cultivator are marked out carefully on the surface of the water by long bamboos stuck up in it, and they pay so much the acre for the portion they till. The long straws of the plants reach up to the surface of the water, upon which float their green leaves; and their pure white flowers expand beautifully among them in the latter part of the afternoon. The nut grows under the water after the flowers decay, and is of a triangular shape, and covered with a tough brown integument adhering strongly to the kernel, which is white, esculent, aud of a fine cartilaginous texture. The people are very fond of these nuts, and they are carried often on bullocks' backs two or three hundred miles to market. They ripen in the latter end of the rains in September, and are eatable till the end of November. The rent paid for an ordinary tank by the cultivator is about 100 rupees (£10) a year. I have known 200 rupees to be paid for a very large one, and even 300, or £30 a year. But the mud increases so rapidly from the cultivation that it soon destroys all reservoirs in which it is permitted; and where it is thought desirable to keep up the tank for the sake of the water it should be carefully prohibited."

In Kashmir, miles of the lakes and marshes are covered with it, and the fruit forms the staple food for some months in the year to a large number of people. It abounds in starch, resembles a chestnut in flavour, and is eaten either raw or cooked. Flour is made of it, which is eaten by Hindus on fast days, also made into sweetmeats.

A variety of *T. natans*, to which the name of *T. verbunensis* has been given, is cultivated in the Lakes of Majena and Varesa in Italy, especially in the Bay of Angera, Lake Majena, where the bottom is visible. With the seeds chaplets of beads are made, and sold in Rome, Varesa, and other places. Necklaces made of the nuts are also sold at Benares, and considered very sacred.

Capt. J. P. Pogson, of Simla, advocated some years since, in the "Journal of Applied Science," the more extended culture and utilisation of this plant. "With the example of Kashmir before us, it seems very singular that the vaunted tanks, large lakes, and inland fresh-water sea of the Madras Presidency, as well as the immense 'jheels' of the North-Western Provinces and Oudh, are not, as a rule, turned to most profitable account by being placed under Singhara cultivation. The dried nuts will, I believe, keep for many years, and as arrowroot, or rather Singhara starch, will always sell in England, either as food or for manufacturing purposes, all old Singhara stock could be so converted and sold.

"Like the grain of wheat, the kernel of the Singhara nut is capable of sustaining life for an indefinite period, and is palatable, whether seasoned with salt and pepper, or made into porridge with sugar, ghoor, or jaggery. If the kernels are broken into small

bits, they may then be ground into meal in a hand-mill, and the produce kneaded up into dough, and made into small 'chuppaties,' or cakes. If the kernels be soaked overnight in cold water, next morning a simple boiling converts them into food—steaming would do as well, perhaps better; but I have, as yet, only tried the soaked kernels in the boiled state. I have, years ago, eaten 'hulwa' made of Singhara meal, and it was more palatable than that made from fine wheat flour.

"The Madras Presidency possesses some magnificent ancient waterworks. The Viranum tank, with its area of 35 square miles, and its embankment of 12 miles; Cauverypank tank, with its embankment of 4 miles, rivetted along its entire length with stone; the Chembrumbankum tank, looking like a picturesque inland sea, are of unknown antiquity. The first of these artificial lakes equals 22,400 acres of surface, and the third being compared to an inland sea, may be ten times that size. It is an officially authenticated fact that in Kashmir, 30,000 human beings are, for five months out of the year, fed and sustained on the Singhara nut, and if the picturesque inland sea under notice is at all deserving the name, its bed and water surface might be most profitably utilised by being put under Singhara cultivation. The tank of 35 square miles might become a first-class nursery for supplying seed nuts to Madras.

"The productiveness of the water-nut, per acre, is at present unknown; but supposing the yield to be four quarters (480 lb. each) of nut kernels per acre, then the 22,400 acres would give 43,800,000 pounds of food, and at 60 lb. per adult per month, the above quantity would suffice to feed 716,800 human beings for one month, and 143,360 adults for five months. The cost of this large and perennial supply of food would be a mere trifle. There are 4,000 square yards in one acre, and allowing one seed nut to each yard, the price of the nuts and the railway freight may be easily calculated. The first year's harvest would more than cover all cost, and thereafter in perpetuity a harvest would result which would only have to bear the cost of watch, ward, and collection. The entire crop being State property, a very considerable revenue would be derived from the sale of the nuts, even if the kernels were sold at half the price of rice or other grain.

"In good seasons, the agricultural population would freely use this cheap and nourishing food, and sell and export rice crops, &c., and in bad seasons of famine the growing crop of water-nuts would be a stand by. In fact, their presence would go far to prevent the artificial production of local famine.

"The nuts once sown re-sow themselves, and in this way the square yard might soon be growing nine water plants or more. The inland sea, when covered with these nuts, would be a source of wealth to the State, and the public would be greatly benefited. As the annual extension of the cultivation, spontaneous and artificial, is a very simple affair, the Madras Government would, in a few years, find themselves to be the proprietors of very valuable Singhara plantations."

Captain Pogson, writing from Simla, states:—"The Singhara nut of India and Europe bears fruit annually from the old roots being a perennial aquatic plant. If sown in water two feet deep, the nuts may be gathered by going in, wading about, and collecting them in a floating vessel, say a five-gallon cask. If in deeper water, any sort of raft, float, or canoe will have to be used, and the nuts picked off. In this country (India) several pickings take place during the season, and the last batch of nuts, *i.e.*, those that are of a large size and the kernel hard, are boiled and so eaten. Others are shelled and dried and made into meal, while others again are buried whole, to be used next season for seed. For example, the pool or depression which has borne a crop of nuts may dry up during the hot weather; when the rains commence the locality will become a pool *de novo*, and the stock of seed-nuts are then dug up and sown twelve inches apart in the shallow water, putting each nut about two inches deep in the submerged soil, and this process is repeated daily as the waters rise. In due course the nuts will germinate, and yield that year's harvest. Of course, if the water did not dry up the old roots would remain alive, and in season send up a fresh crop of stems, which would in due course bear fruit. Hence, if required to become a perennial crop, the nuts must be sown in the beds of shallow freshwater pools which never dry up."

The Pythagorian bean, the *Nelumbo nuciferum*, Gaertnar; *Nelumbo speciosum*, Willdenow; and another species (*N. luteum*), have seeds of a particularly pleasant taste. The capsular fruit contains from twenty to forty of these seeds. The seed-vessel is of a peculiarly beautiful form, the top becoming detached when ripe, discloses a chamber with five partitions. The seeds were much used as food in ancient Egypt, but seem to be neglected now. These retain their vitality for several years. The tuberous roots of both species resemble the sweet potato (*Batatas edulis*), and are starchy. The root-stocks when boiled are farinaceous and agreeable, and employed as food by the Osaga and other Western Indians.

The seed-vessel, or receptacle of the fruit of the lotus (*N. speciosum*) is large, in the shape of an inverted cone, and has the nuts placed loose in apertures, or cells, on the surface; it has not inaptly been compared to the rose of a watering pot. The whole, in process of time, separates from the stalk, and laden with ripe oval nuts, floats down the water. The nuts vegetating, it becomes a cornucopia of young sprouting plants, which at length break loose from their confinement, and take root in the mud. The lotus flower is highly venerated by the Hindus, and is given as a valuable offering to the gods. The seeds, in India, are eaten raw when green, and roasted or boiled when ripe and hard. The root,

which is two or three feet long, is eaten, boiled, as a vegetable.

The Klanath Indians of North-West America live chiefly on the "tookow," or seeds of the yellow water lily (*Nuphar lutea*), which is the staple of their winter food. The capsules are broken, and the seeds separated from their husks.

FURTHER LONDON CHANGES.

In previous numbers of the *Journal* reference has been made to the more extensive street changes that have been effected in London in recent years.

Another very important one is on the point of completion. In the autumn of last year the clearance was commenced of the district lying between Sloane-square on the north, Chelsea Barracks on the south, Lower Sloane-street to the west, and a somewhat irregular line to the east running from Sloane-square Station to Pimlico-road. During the last two weeks of April the hoarding in Lower Sloane-street has been removed, disclosing an ornamental garden separated from the street by iron railings. It is already in part laid out, and a row of trees runs just inside the railings. The district was one of narrow streets and courts of dirty and, in many cases, neglected aspect, and the mostly uncleaned population that hung about the corners made the approach to Battersea-park, *viâ* Victoria-bridge, not a pleasant one. From Albert-gate, down Sloane-street, there have for a long while been trees in sight all the way. This present improvement will carry on the line of green to Ranelagh-gardens, and the grounds of Chelsea Hospital and Chelsea Barracks. From Hyde-park to Battersea-park there will shortly be trees in view all the way. The beautiful Chelsea-embankment, which is free from the traffic of other embankments, will be more pleasantly accessible. On the west side of Lower Sloane-street several of the high red brick houses are already nearly complete, and they afford a striking contrast to those round about which have not yet been pulled down. The for ever gone Chelsea Market and its surroundings had a certain interest as an old centre of a population mostly surrounded by fields, but few who have seen it in its later years can regret, from a sanitary point of view, that it is now a matter of history only. "Turk's-row," with its collection of costermongers' barrows, piled ready for going rounds on Saturdays, and the courts south of it, yet remain as an example of the district, but in the courts the "housebreaker" is already at work. A row of cottages near Blacklands, looking last summer pretty with their little gardens and creepers, have had to give way to a large red brick building rapidly approaching completion.

At the beginning of this year demolitions were commenced which are entirely altering the aspect of an adjacent district lying west and north-west of Sloane-square. Draycott-terrace, Leete-street, Symonds-street, &c., have been not only in part cleared, but the new houses are far advanced. The old-fashioned, narrow, irregularly-paved ways, where houses appear to have been crowded in where formerly there were open spaces, are here gradually giving way to wider thoroughfares, with loftier houses, following a regular frontage line, though showing differences in styles in elevation. Further on, in the direction of Chelsea Old Church, there are numerous changes. The frontage of Queen's-road west, which had some rather picturesque houses, is being changed; here the garden spaces are being preserved. Flood-street is, piece by piece, being altered, but on the east of it—an extensive space obtained by the clearance of many narrow streets and courts—no rebuilding has yet been commenced. Further west still many small clearances have been made, which are followed at once by rebuilding.

Looking at all these districts from a health point of view, it is undoubted that the sweeping away of narrow lanes and courts with ill-kept houses, and the substitution of wide streets, with buildings constructed with proper sanitary appliances, is a gain. The laying out of ornamental grounds and the planting of trees is a gain. The nests of courts came from the crowding in of cottages on garden ground. All this work of opening up space is undoing the mischief which gradually came about thoughtlessly from immediate need of dwelling accommodation before attention was paid to sanitation. But the question naturally arises—What becomes of the crowded population that has to leave the courts? What effect does the securing of open space, wide streets, garden and green in one part of London have on other parts?

A reference to recent changes of a kind just the reverse to those alluded to may help to furnish an answer. A few years ago there used to be a pretty way of reaching Wimbledon by going through Battersea-park, along the road to Wandsworth. There were cottages, detached, semi-detached, or in little groups. The little gardens were, for the most part, well kept, and had a bright and cheerful look. Hedge rows and trees remained in several parts of the route. The cottages now are gone, rows of shops and buildings occupy their place, pavement with its crowds is where the pleasant side paths used to be; a convenient tram-road helps people from place to place; but as for gardens or trees, or green of any kind, it is only here and there they can be seen. The people dwelling in the new district have more space and air than they had in their old and now demolished abodes, but there is an absence of all brightness, such as formerly characterised the road. It seems not improbable that the course from an open district to a "slummy" one is being run here, but more rapidly than in former years in older parts of London.

Whether owing to the mortar or the bricks now

used, it seems to need but five or six years to change a bright-looking set of small houses to a dingy appearance. It has been said the working classes need stronger buildings than those of gentler occupations. They seem to have them weaker or they neglect them. The bright look of rows of houses on "estates" erected a few years back is gone. Mortar flies away in dirt, the exposed edges of bricks yield to the weather, floors bend, ceilings crack, walls peel, and doors and windows get out of square. About ten years ago a district about half a mile long was built on from near Loughborough Junction to near Herne-hill Station. It at first looked attractive, and there were green walks within ten minutes reach. It was quiet, had a semi-country look, and the little gardens and creepers gave promise of a pretty new district. Now there is hardly a garden attended to, the creepers do not "take kindly," as the gardeners express it, to the modern bricks and mortar, and even the ventilating grates under the joists of the ground floor are in most cases choked up. A tramway is laid along this road also. A curious case of mortar crumbling away and spoiling creepers and gardens can be seen in a comparatively new road (opened as a thoroughfare only two years ago) between Kimberley-road, leading off the Stockwell-road, to near the Bon Marché at Brixton.

The pretty walk from Parson's-green to Putney-bridge is a thing of the past, and among other changes for building, a fine avenue of trees was cut down.

It seems that while in London itself spaces are being cleared, gardens are being laid out, and trees are being planted, the process in the suburbs is just the reverse. Open spaces are being covered with rows of houses, gardens are being destroyed, and timber and fruit trees are being felled. Perhaps it is no one's fault. The "jerry builder" seems a recognised necessity of the age. But possibly at no distant period it may be found requisite to re-buy some of the land—allowing handsome compensation—for the purpose of forming small recreation grounds, with a few trees and a little green, in the health interests of the children of an overcrowded population.

SCHOOL OF FORESTRY IN SPAIN.

Her Majesty's Secretary of Legation at Madrid says that as far back as the close of the 15th century, that is to say, in the reign of Ferdinand and Isabella, legislative measures were enacted for the promotion of forestral science, and there is reason to believe that previously to that period royal ordinances had been issued to check the reckless destruction of fine timber with which the country was so richly provided. In the year 1835 special ordinances were enacted for the formation of a school of forest engineers, but no practical steps were taken in this direction until ten years later, when the *Escuela especia de Ingenieros de Montes* (school of forestry) took firm root, and was followed by the formation of a corps of forest engineers. The first school was located at Villaviciosa in the province of Madrid. In 1868, the Government granted a petition addressed to it, whereby a suitable building, forming part of the Escorial, became the premises of the school of forestry, whither it was removed from Villaviciosa the following year. This institution is under the direction of a head administrator and chief engineer of the first class, under whom are nine professors and three assistants, all of whom must have served for five years on the active staff of forest engineers. Their salaries, while employed at the school, are charged in the annual budget of the Minister of "Fomento" (Public Instruction, Agriculture, Industry, and Commerce), and amount to about £1,400 a year. The total annual cost of the establishment is about £1,700. Instruction at the school is gratis; books, stationery, and instruments being alone charged for. During the year there are nine weeks vacation, viz., four days in December, during the carnival, and the months of August and September. The latter is, however, subject to modification, depending upon the completion of the practical work. The number of students is not limited, and is dependent on the number of successful candidates for entrance each year. There is, likewise, no limit of age. At the present time there are ninety-two students at the school. The hours of study are three hours in the morning, and three hours of practical work in the afternoon. On the completion of the course at the school, lasting four years, the successful candidates are appointed to the corps of forest engineers, incorporated by Royal Decree of the 17th March, 1854. This corps consists of three general inspectors of the first class, fifteen district inspectors, forty chief engineers of the first-class, fifty chief engineers of the second class, sixty first and seventy second engineers of the second class. In addition to the above, there are twenty-five assistants of the first class, three hundred and fifty assistants of the second class, and four hundred and twenty foremen planters. The custody of the public forests is vested in the civic guard. The salaries of the six grades of forest engineers are, respectively, £500, £400, £300, £260, £200, and £160. They have also an active service allowance of £1 per day to inspectors, 16s. a day to chief engineers, and engineers of the first and second class 12s. a day. The inspecting officers reside in Madrid, and form the consultative board; the remainder are stationed in the forestal districts into which Spain is divided. The country is divided into 46 forestal departments, the forest in each being under the care of a chief engineer. The three principal head-quarters are Soria, Cuenca, and Yaen. The course of instruction at the Escorial School is divided into two categories, viz., preparatory and professional. In order to enter the school the candidate must produce a diploma of

proficiency in the following subjects:—Spanish and Latin grammar, geography, and Spanish history, and the following preliminary examination must be passed prior to his admission: elements of natural history, elements of theoretical mechanics, geometry and its relations to projections and perspective, physics, chemistry, lineal, topographical, and landscape drawing, and an elementary knowledge of French and German. Application for admission into the school must be made in writing before the beginning of the autumn term, and on entering the school especial attention is devoted to topography, chemistry, and mathematics. The first embraces the following:—The object of topography, and the difference between it and geodesy; the rules of triangulation, and methods of demonstrating the physical characteristics of the ground under survey; chart and plan drawing, and an intimate acquaintance with the use of instruments employed in forestal topography. The chemical course is very comprehensive, and includes every detail of the applied science appertaining to botany, mineralogy, and sylviculture. The school is admirably furnished with chemical apparatus and instruments, many of which are of great value, and include those of the great inventors, Bunsen, Dupasquier, Mitcherlich, Donovan, Guy Lussac, &c. The school library is well supplied with suitable works, of which there are over 3,000 volumes, including works on mathematical and physical sciences, natural history, ethics and politics, literature, languages, history and geography, arts and manufactures, and encyclopedias in great variety. The studies of the first year are topography, integral and differential calculus, descriptive geometry, applied mathematics, and chemistry. The second year includes the theory and application of mechanics, geodesy, meteorology, climatology, construction, and drawing. The third year is devoted to the study of mineralogy and applied geology, applied zoology, applied botany, and sylviculture. In the fourth and last year the studies embrace kilometry, scientific classification of forests, forest industries, law, and political economy.

COMMERCIAL MUSEUMS.

The *Board of Trade Journal* contains the following particulars respecting the commercial museums at Milan, Buda Pesth, Oporto, and Frankfort, and of the bureaus of commercial information at Vienna and Belgrade; also information respecting the museum to be opened at Tangiers in October next.

The *Schweizerisches Handelsamtblatt* states that, although opened so recently as June, 1886, the Milan Commercial Museum has already rendered important services to Italian industry. During 1887 a great deal of business was effected entirely through the museum, and the Italian Government is beginning to awaken to the value of this institution. It has lately shown this by an increase in the subsidy. The museum publishes a bulletin twice a month, describing all specimens received since the last publication, and adding all such facts and general infcrmation as can be deemed important in the interests of Italian export trade.

According to the French *Journal Officiel* for the 12th July last, the Belgian Consul-General at Buda Pesth reports very favourably of the usefulness of the Commercial Museum of Buda Pesth. This museum has been established by the Austro-Hungarian Ministry of Commerce, and its budget is covered by a subsidy from the Government, augmented by contributions from the Chamber of Commerce, from the Austrian Lloyds, and from various societies.

The object of the Buda-Pesth museum is not, like that of Brussels, to show to producers specimens of the articles in demand in foreign markets, but solely to exhibit whatever is manufactured in Hungary, and thus to place the Hungarian nation in a position to know what its own products consist of. It is not merely an exhibition, but a vast market as well, and it occupies the large spaces engaged for the Pesth Exhibition of 1885. The only articles excluded are those which are excessively cumbrous or dangerous, as locomotives on the one hand, and explosives on the other.

The *Receuil Consulaire Belge* says that the Commercial Museum opened at Oporto on the 21st of March of last year has proved a great success. It contains very numerous specimens of all the small domestic trades of Portugal. From January to April of the present year 8,251 persons visited it. Most of the articles exhibited are Portugese, for very few foreign manufacturers have made any response to the invitation to send their products to the Oporto Museum.

The French *Journal Officiel* for the 25th of July last states that according to the annual report of the Frankfort Chamber of Commerce, 6,539 persons visited the Commercial Museum in that town during 1887. The condition of the museum is in every way satisfactory, and its collections are being rapidly added to.

The *Bulletin du Musée Commercial* for the 30th of June last says that the Vienna Chamber of Commerce eatablished, two years ago, a Bureau of Commercial Information respecting Russia, Italy, Turkey, the Danubian countries, Spain, Portugal, South America, Africa, and Australia. This bureau was instructed to centralise all information respecting trade and industry in these several countries received from the various Austro-Hungarian Consulates.

This step has produced the most satisfactory results to Austrian commerce, which has thus been able to work on accurate data.

The Minister of Foreign Affairs has recently proposed to the Vienna Chamber of Commerce to extend to Germany, France, England, Belgium, and the United States the system of this information, and thereby widen its sphere of usefulness.

The *Revue de l'Orient* for the 24th of June last contains information respecting the Commercial Information Office lately established at Belgrade.

The Servian Minister of Commerce is now making every effort to increase the export trade, to give confidence to the commercial world abroad, and to furnish every guarantee to capital employed in Servia.

The Government has given instructions to préfets, sous-préfets, and mayors, requesting them to assist in any case foreign merchants and manufacturers; the latter will thus be informed of the commercial laws and customs in vogue in Servia, of the manner in which bargains are made, of the method of drawing up contracts, and of giving them the force of law, &c. The agency will reply to letters written not only in Servian but in all European languages.

The *Recueil Consulaire Belge* states that in the course of the month of October an International Commercial Museum will be opened in the city of Tangiers, in Morocco, for the purpose of encouraging trade between that empire and foreign countries, and of familiarising the Morocco merchants with articles imported from Europe.

PRODUCTION OF ROMAN WINE.

The wine production of the province of Rome (Latium), which has always been considered one of the most important and renowned in Italy, has increased in late years, and great improvements have been attained as to the qualities of the wine produced. The principal group of wine-producing districts in the province of Rome is known under the appellation of "Castelli Romani," and it is composed of the territories of Velletri, Civita Lavinia, Genzano, Albano, Marino, Grottaferrata, Frascati, and other minor places. Consul Franz, of Rome, says that the land is of volcanic origin, and the cultivation is carried on under good technical rules, differing very little from those followed by the ancient Romans, which have always been considered to be the result of great wisdom and judicious experience. In former years the cultivation of the white grape prevailed, but of recent years the new plantations consist chiefly of black grape vines. In a very short time, therefore, red wine will hold a prominent place in Latium, the same as in the other principal vine-growing districts of Italy. The wines produced by this group are naturally robust and durable. It is the custom, however, in order to ensure their preservation, to remove the wine from the cellars to subterranean caves. These caves consist of long corridors or galleries hewn out in the layers of tufa stone, having lateral niches, in each of which a butt is placed holding between eight and twelve hectolitres, the hectolitre being equivalent to twenty-two imperial gallons. These subterranean caves are ventilated by means of wells, and even at the very height of summer the wine is thus kept at a very low temperature. The volcanic nature of the soil imparts to the wine of the "Castelli Romani" special qualities, and when old, they turn out agreeable to the palate, and healthy to a high degree. The wine produce in the suburbs of Rome is also increasing in quantity, but it is less appreciated. The vines yield less fruit than those of the "Castelli Romani." Still less appreciated are the wines produced in the province of Viterbo, notwithstanding the fact that some of the qualities produced there are good, and renowned, such as the Orvieto, Montefiasconi, and Montepulciano. Some increase in the culture of the grape vine is noticeable along the sea coast especially in the vicinity of Civitavecchia, Nettuno, and Terracina. So far, however, the result has not been such as to allow of an opinion being given as to the success of the vine culture in those territories. It is believed that on account of the sandy nature of the soil, the vine plants may be free from the serious ravages of the phylloxera. The average annual produce of the province of Rome is at present estimated at 42,420,000 gallons. In the Umbria, and in the Marche, where white wine was formerly produced to a large extent, the cultivation of red grape vines is now chiefly practised. The average production of wine in each of the provinces constituting the Marche and the Umbrian district is as follows:—Province of Pesaro, 6,600,000 gallons; Ancona, 6,094,000; Mascerala, 10,608,000; Ascoli Piceno, 8,448,000; Perugia, 22,500,000 gallons, making a total of 54,500,000 gallons. The closing of the French market to the Italian wines, which market absorbs more than three-quarters of the total quantity of wine exported from Italy, will indirectly affect the production of wine in Latium Marche and Umbria, although the quantity exported from these districts is not so important as that which used to be exported from other provinces in Italy. It is the intention of the Government to enact stringent legislative measures with reference to the adulteration of wine, and the agrarian stations in Italy are instructed to analyse the wine which is presented to them by the public for that purpose. They are to consider as adulteration the addition of any substances which are not to be found in pure wine, or the use of which is not in accordance with the rational principles on which wine-making is based. It is also to be considered as adulteration the addition of substances which are naturally to be found in wine, if these substances be beyond the ordinary limits or just proportions, as they exist in pure wines. As an exception the use of gypsum is allowed. The maximum quantity of sulphate, however, is determined by the Superior Board of Health. In conclusion, Consul Franz states that a committee, composed of the directors of the principal banks, has furthermore been appointed by the Government, with the object of proposing the best means of affording large financial support to the Italian wine industry.

DATES IN TUNIS.

Tunis dates, says Consul Sandwith, may be considered superior to those of any other country, and yet they are but little known in England. They are the produce of the extensive oases in the south of Tunis, those of Jerid and Tuzeur being the most extensive. The date palm grows all over the regency, but the few trees met with in the north do not ripen their fruit from want of heat. Even the palm trees of the oasis of Gabes, situated in latitude 34°, produce an indifferent fruit owing to its proximity to the sea, which reduces the temperature of the air. The Arab saying is that the date palm loves to have its feet in the water, and its head in the fire, which graphically expresses the craving of this tree for moisture and heat. The best quality of date is that known by the name of Degla, which is large, tender, and very sweet, with skin unwrinkled, and of a golden brown; these are exported chiefly to France. In the market of Tunis this quality sells, retail, at threepence per pound. The Custom-house statistics only show an export of the value of £1,200 to Great Britain and Malta. Consul Sandwith says that as steamers direct for Liverpool call at Gabes for Alfa, it is surprising that a more extensive trade is not carried on in this fruit. It constitutes the principal fruit of the Arabs, the oasis of Tuzeur, alone, produces annually about 16,000,000 pounds. The average annual exportation does not exceed a value of £12,000.

NETHERLANDS TOBACCO TRADE.

The following information, extracted from a recent report by Mr. W. C. Robinson, her Majesty's Consul at Amsterdam, is taken from the *Board of Trade Journal*:—

"The tobacco trade during 1887 was large, brisk, and profitable. The Amsterdam market has become more and more the principal one in Europe, in consequence of the excellent quality of the Sumatra tobacco, which is sought for here by buyers from all parts of the world, and especially by the American cigar manufacturers, and of the large amounts of Dutch capital invested in the plantations of Sumatra, Java, and Borneo, the extent of which is daily increasing. The crop of 1886 was the largest hitherto known. Sumatra sent to Holland, in 1887, 138,000 bales, value £2,660,000, as compared with 125,000 bales, value £2,300,000, in 1886. North America alone purchased in our market for £1,160,000. Prices slightly improved, partly in consequence of the demand for the finer qualities for cigar-making, for which extra rates were paid. The measure taken by the English Government, fixing 35 per cent. as the limit of water to be added by the tobacco manufacturers, was a severe blow to the sale to England of Java tobacco, the absorptive power of which is very great. Borneo is now beginning to send some tobacco of excellent quality, and the produce of British North Borneo is now looked forward to with much interest. The dividends of the more important Sumatra tobacco companies were again very high—the Deli Company 109 per cent. per annum, and the Arendsburg Company 169 per cent."

General Notes.

CHINESE NEWSPAPERS. — The British Consul-General in Shanghai, in his last report, refers to the growth of the native newspaper press in Shanghai. Besides religious and illustrated periodicals, there are two daily newspapers published in Chinese there, the *Shen Pao*, published by an Englishman, and the *Hu Pao*, which is published at the office of the leading English newspaper in China. The former has an average daily circulation of 12,000 to 13,000 copies. During the Franco-Chinese war, its articles being written by patriotic Chinese to suit the popular taste, the circulation increased to 18,000 copies daily. The price is 10 cash, or less than a halfpenny, yet it is often sold after perusal, sometimes changing hands more than once during the day. It is then bought by *employés* of the Chinese post-office, who send it to places in the interior where steamers cannot reach. The *Hu Pao* has also a considerable circulation, especially within the Kiangsu province. Both papers, says Mr. Hughes, though owned by foreigners, are *bonâ-fide* organs of Chinese educated public opinion. In international questions, they do not always take the foreign side, but their influence is, on the whole, exerted in favour of progress and civilisation.

PAMPAS GRASS AND PLUMES.—Pampas grass, bearing plumes, are cultivated, more or less, throughout California, but in the southern part of the State alone are they grown for profit. Although some large bunches may be seen in the gardens of San Joaquin and Sacramento valley that attract the eye of the tourist, and which, by constant attention, produce beautiful silvery plumes, it is only in Southern California that the monster bunches of Pampas grass, and long silvery plumes, which always command fancy prices in the market, are grown. Until late years, Santa Barbara has been the largest producer of this feathery-like grass, but since some of the nursery gardeners of Los Angeles have given their attention to the cultivation of this plant as an article of export, they have completely eclipsed their neighbours both in quality and quantity. The plumes are harvested in September by carefully cutting the stalk, and after being dried for a day or two in the sun they are ready for export. Two pampas meadows, near Los Angeles, furnish a product of 250 dollars per acre, with little or no expense beyond gathering the plumes. A constant market is found for these beautiful feathery ornaments, which are coloured with all the hues of the rainbow, in the Eastern States and in Europe.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

Prizes are offered to Art-workmen in the following classes:—

I. Pottery (Including Porcelain and Earthenware):

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5; second prize, £2.
   b. Shaved or turned, first prize, £5; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Painted under glaze, first prize, £10; second prize, £5; third prize, £3.
   c. Enamel on the glaze, first prize, £10; second prize, £5; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain; incised and glazed, first prize, £10; second prize, £5; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10; second prize, £5; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25; second prize, £15; third prize, £10; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25; second prize, £15; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for the outside of a window, for a street-door panel, or for indoor use as a window screen, coil case, ventilator, &c.

IV. Goldsmiths' and Silversmiths' Work.

[Prizes presented by the Goldsmiths' Company.]

A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First Prize £20; Second Prize £5.

A pendant or brooch, or locket of gold without gems. First Prize £20; Second Prize, £5.

All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered have appeared in previous numbers of the *Journal*.* They can also be obtained on application to the Secretary.

PROGRESS OF SANITATION, CIVIL AND MILITARY.†

By Edwin Chadwick, C.B.

When, in 1881, I presided over one of the sections of the Congress held here, the chief topic of my address was on the sanitary defences against severe epidemics, when it was shown that by sanitation and by house-to-house visits and treatment of the premonitory symptoms of the cholera, fully 50,000 lives were saved beyond the rate of loss in Sweden, where the ordinary death-rate was lower than in Great Britain, but where our precautions were not taken; that at St. Petersburgh by the adoption of our practice some 20,000 lives were saved at each of two visitations. But, perhaps, under the influence of the false Malthusian theory, still prevalent amongst ill-informed politicians, no notice was taken and no recognition given to the prevention of losses of life greater than in the heaviest battles. It is characteristic of the common state of the popular information with which we have

* See *Journal*, June 15.

† Presidential address delivered before the Association of Sanitary Inspectors of Great Britain, at Brighton, August 25th, 1888.

now to deal, that while a single death from violence or passion excites general attention, deaths weekly from preventible causes pass without any notice whatever. I may now, I conceive, best submit a view of the progress made in sanitation since then. I take, as the test standpoint, the death-rate for the previous year, 1880, when it was 20·5 per 1,000 of the population of England and Wales. In 1887 the death-rate was 18·8. In the last quarters of this year it was 17·6 per 1,000. The recent modified death-rate, mainly from preventible causes, in the year 1887, was only 18·8; and on Dr. Farr's estimate of the average value of each life the saving in 1887 was £7,635,000 in money—nearly the amount of the poor-rates for the year. Examining the reports sent to me of the work done in a number of towns, and comparing them with each other, looking particularly at the work done by the sanitary inspectors under the direction of the health officers, as to the number of houses in a bad sanitary condition which have been improved under their direction, and as to the accumulations of putrefying matter which they have removed, it is certain that a large share of the reduced death-rate is due to their service—imperfectly as it is yet organised, and obstructed as it still is. Looking, however, at the extraordinary recent reductions of the death-rates in the metropolis (where it was not long since 24 per 1,000), but has recently come down to 14 or 15 per 1,000, I cannot but consider that much of the reduction must be due to climatic causes. On the occurrence of a great thunderstorm, immediately after it has cleared away there is an experience of a new and fresh atmosphere. It has done for a time what must be the constant work of good sanitation. Good sanitation will, however, do more than that permanently. By the Consolidated Metropolitan Sanitary Commission, which had charge of the whole of the house drainage as well as the drainage of the roads, and also of the land drainage of the suburbs, plans based upon trial works of blocks of buildings—which trial has since been verified by the results of work in a number of towns where the system of "circulation *versus* stagnation" is followed—constant supplies of pure spring water would, by this time, have been carried into every house, or on to every flat in every house, without cisternage and stagnation and de-aëration. The fouled water would have been constantly carried out of every house by self-cleansing house drains and sinks into the self-cleansing sewers of the streets, and from those self-cleansing sewers on to the sewage farms or gardens fresh and without loss of strength by putrefaction. What would have been the grand result of this system is indicated in towns more or less completely on the separate system, for in those towns there is a reduction of the death-rate by fully one-half. And there can be no reasonable doubt that all of the like reductions might have been effected on the same principle in the metropolis and in other cities. It is too long a story to describe the combination of sinister interests, in expensive Parliamentary procedure and in expensive works, by which the Government were put in a minority against the continuance of the first General Board of Health and of the Metropolitan Sanitary Commission. By that first General Board of Health local authorities and executive officers were distinctly warned that they were responsible under the old common law categories for acts of "non-feasance," of "misfeasance," and of "malfeasance." If an architect or a contractor supplied with a good plan, and with the latest improvements before him, were, from *mala praxis*, to construct an edifice with a large stagnant cess-pit beneath, productive of disease to the occupants, he would certainly be liable in damages for his malfeasance, and it admits of clear proof, from what has been done in various other towns, that, had the works on the plans prepared been fairly, in the metropolis, executed, that the metropolitan death-rate would at this present time be reduced by at least 5 per 1,000, and would probably have stood at 12 per 1,000 from the year 1856. The river also would have been purified first instead of last, and would now be pure instead of being in a condition which Lord Bramwell's Commission described a "a disgrace to the metropolis and to civilisation." It appears to me to be of importance at this time to display in the way of warning the wholly unimagined and gigantic extent of evil of sanitary "malfeasance" in the results on the metropolis, the cost in lives, and of the value in lives chargeable and inflicted on the metropolis *mala praxis* and by "malfeasance." As to the value of lives, I take the estimate of Dr. Farr in relation to the average actual cost. and the average actual value of every human being in England at £159. The total loss of lives every day has been 98, and the loss of them in money value has been, every day, £15,523. Every week the average total loss of lives has been 685, and the total loss in money £108,963. Every year the total loss of lives in the metropolis has been 35,636, and in money £5,666,059. Such will be found to be the rate of the cost of the delay of the practical application of the power of sanitary science in competent hands for the future. I submitted these results to Lord Herschell as charges for investigation under the commission for the examination of the working of the Metropolitan Board of Works. No doubt the discrimination of cases would have been difficult between the individuals who were, we must assume, utterly unconscious of what they were being made to do, and those that were not, or who, in ignorance of the *mala praxis*, nevertheless could not now equitably be subjected in such penalties as would have befallen them from the judges of old. No doubt, also, the investigation would have been laborious and difficult, yet it would have been useful for the public instruction and for the future warning to local administrative authorities. But as the proved acts of malfeasance in comparatively small

matters have served in the minds in Parliament, as well as of the public, for the discontinuance of vestry authority in such matters, it seems to have been considered unnecessary to enter into the examination of such large and complicated inquiries. It is, nevertheless, of vital importance that the powers of the great factors of sanitation should be vindicated, and shown to be so certain, from what has been done, that a capitalist would be safe, from proof, of a reduction by one-half of a death-rate, in contrast with a reduction contracted for of one-third. A contractor, with enlarged and commensurate powers, might contract for the reduction of the excessive death-rate of Manchester (now 27) to 16 per 1,000. And this reduction would be attended, as shown in the manufacturing town of Leek, with an augmentation of five years of the average duration of life and working ability. And at what cost? At not above one-third of the insurance charges of the twenty-four millions of money annually paid by the wage classes of England to provide against excessive sickness and premature mortality, nay, I believe, at not above one-third of the insurance charges against sickness and mortality enforced by a special executive machinery made by Prince Bismarck in Germany.

The sanitary works of drainage and improved water-carriage are, however, sometimes countervailed by overcrowding. Let us look at the case of the working man under that condition. In some experiences got out at Glasgow, it is there shown that there is an excessive death-rate in single-roomed tenements, but a lower death-rate in double-roomed tenements. Dr. J. B. Russell, the Health Officer of Glasgow, states that 125,000 of the wage classes live in those over-crowded one-roomed tenements, in which he pourtrays conditions in which morality and health are impossible. Increased living-room space must be paid for, and is it not worth while for the mechanic who is getting 25s. a week, to pay 2s. or 3s. a week more for such space as he may get in a model dwelling, in which it is proved that, on an average, he obtains full ten years more of life and working ability? Compare this with the fate of a man who emigrates to a city in the United States, or to one of the Australian colonies, where the death-rate is 27 in 1,000, and who will lose by one-third his chances of life and working ability, and if he have a family, will see one-half of his children in their graves by their fifth year.

I beg to offer some further illustrations as to the means of dealing with the important subject of overcrowding. When I was examining the slums of Edinburgh, I met an occupier of one of them whom I well remember. He was a strong, well-built man, who answered the questions I put to him with great clearness. He was a porter, and earned more than 20s. a week. I asked him how he expended the wages he got, and he stated the details of his expenditure with apparent honesty. "But these only amount," I said, "to one half of your earnings; what do you do with the rest of your wages?" "It goes in whiskey," he said. I could not help expressing my surprise and concern that so sensible a man as he was should give himself up to such a course. "Well, sir, this is the only place I could get; and if you were to live here you would drink whiskey too." It so happened that whilst I was there I did feel a coppery taste in my mouth, a premonitory symptom from so depressing an atmosphere, and immediately I left it, it is the fact that, rightly or wrongly, I sought correction in a diffusive stimulant, some warm brandy and water.

The provisions which are supplied for the measure which Lord Shaftesbury got passed for the regulation and prevention of overcrowding in common lodging-houses were that they should be cubed up, and that only a limited number of lodgers should be allowed in one room; that the rooms should be properly supplied with water, and with ventilation as it was then understood, with proper drainage by water-closets. These provisions, carried out in the metropolis by the police, have sufficed to clear the houses of the epidemics, of which they were previously the first centres of the heaviest attacks. The local health officers have proposed that some effective provisions should be applied for the protection of the wage classes. Now the rents of the common lodging-houses are paid nightly. It is now proposed that on the occurrence of any case of fever, or of the now excessive death-rates by overcrowding in single rooms, that these same provisions for the common lodging-houses should be applied under sanitary inspection to the tenements occupied by the wage classes, the rents of which are paid weekly. In periods of the greatest prosperity, the changes of work from district to district, leading to changes of residence, are very great, as experienced by the large changes of residence of children, which cause great inconvenience in the Board schools. There are special reasons for the enforcement of the provisions in question for the protection of immigrants. At one-third of his present induced or necessitated expenditure, occasioning a short and wretched existence in a single-room tenement, as in the instance I have stated, the artisan may be enabled to obtain the increased space, in improved residence which will ensure to him a prolonged and healthful working ability, and enable him to make reserves for ease and respectability when that working ability at length naturally ceases.

I deem the greatest gain of sanitary science developed since we last met here the proofs obtained of the power of the prevention of the chief of the children's diseases. In the large district schools, the districts of the Poor-law Unions, the children's chief diseases are now practically abolished. Those institutions may be said to be children's hospitals, in which children, orphans of the lowest type from the slums, are taken in large proportions with developed diseases upon them, often only to die from constitutional failure alone. Yet in a number of these separate schools, there are now no deaths from

measles, whooping-cough, typhus, scarlatina, or diphtheria. The general death-rate is about 10 per 1,000, and of those who are not in the probationary wards, of those who come in with undeveloped disease upon them, the death-rates are now less than 3 per 1,000, or less than one-third of the death-rates prevalent amongst the children of the general population of the same ages. To illustrate this progress of the chief rudimentary and sanitary factors, I may give one example, of an institution where the old death-rate was the common outside one of 12 per 1,000. The institution was first properly drained, and the premises cleared of foul sewage smells, by which clearance the death-rate was reduced by more than one-third, or to 8 per 1,000. Then followed frequent head to foot washing with tepid water, when the death-rate was reduced by more than one-third, and with some other sanitary improvements—namely, better ventilated rooms, and the bedding of the children, with one child only in each bed—the death-rate has been reduced to 3 in 1,000, and that with children of the lowest type. In a visit to one of these half-time schools, after an interval of several years, I was so struck with the appearance of the children, as less pallid, and the less dull, leathery look that I had seen before. They were bright and fresh-looking, and I observed to the manager that he must have had a new class of children since my last visit. His answer was "No," but that since the sanitary improvements had been made in the lower districts, the children received from them had the improved type which had struck me. Other observations on a larger scale in civic populations, where foul tenements have been reduced, streets enlarged, and better ventilation given, show like improvements in the type of the population. The cost of a superior mental teaching power on the half-time schools of the proper size (upwards of 700) is £1 per annum, and of a superior physical training 10s. per head in elementary schools on the half-time principle. If these were made generally prevalent they would effect a saving of £1,500,000 per annum over the present charges of elementary education. Ignorance objects to the cost of living in the district half-time schools, but at the cost of one vagrant, or mendicant, or delinquent living at large upon spoil, two or three children of hereditary mendicants or delinquents receive an industrial and mental teaching, which carries them to the good and increased wages, which has proved the greatest factor in the late reduction of juvenile delinquents.

Let me now exemplify the progress of the power of sanitation as displayed in military services. A quarter of a century ago the death-rate in the Guards was 20 per 1,000; it is now 6½ per 1,000, and, as I could show, it is yet much too high. The death-rate in the home army was 17 per 1,000; it is now about 8 per 1,000. But Germany beats us with her death-rate of 5 to 6 per 1,000. In France it is 10 per 1,000; in Austria, 11; in Italy, 11; in Russia, 18, an army death-rate three times heavier than in Germany. In 1858 I read a paper at the Association for the Advancement of Social Science, at Liverpool, in which I represented the expediency of applying to the protection of the Indian army the sanitary science which had saved the second army in the Crimea. I followed up this recommendation persistently, by official paper after paper and interviews with the authorities, until a Commission was obtained, of which Dr. Sutherland and Mr. Rawlinson, Commissioners of the Crimea, were members. The old Indian army death-rate was 69 per 1,000; from 1879 to 1884 the death-rate was reduced to 20 per 1,000, and now it is about 14 per 1,000. In the six years from 1879 to 1884 the aggregate saving was 16,910 lives, and on the military estimate of £100 per life, the saving in money during the six years (as estimated by our late eminent sanitary ally, Professor De Chaumont, of Netley, whose loss is greatly to be deplored) was £1,691,000; and at the present reduced rate of 14 per 1,000, the saving may again be reduced in proportion.

Seeing the great saving that has been effected by sanitation, so far as the science has been applied in the military service, eminent sanitarians in India have pressed for its application for the protection of the civil population. It appears that its application is generally obstructed by the ignorance of the local authorities, who have yet to be made aware of the gains derivable from it. I have written to our excellent Viceroy in India, Lord Dufferin, upon this subject, and have received from him assurances that he has left provisions for its promotion by examples.

I have recently been made aware of the prevalence in high political statesmanship of a deadly error—that sanitation is opposed to the Malthusian doctrine "that pestilence is the great check to the growing excess of population." Unfortunately, I find a younger generation who have never read the demonstration of that great error given in my report of 1842, that pestilence is attended by a rapid augmentation of births, and does not reduce the numbers of populations, but only weakens them and augments the proportions of the dependent pauperism. I brought this great error and its deadening effect before our Political Economy Club of London. In the highest sanitary conditions it is observable that the proportion of births to deaths is rather reduced than otherwise. There is one large economical effect which I have recently ascertained is now developed in connection with the sanitation of the German army. From Mr. Aird and the English contractors for sanitary works in Berlin I learn that by the manual instruction and industrial exercises given in the three years' military training, the recruits come out with an improved industrial aptitude, which imparts to them 30 per cent. of higher value in the labour market which they obtain. With this result of improved productive force of the whole of the working population, the military training may be said to cost the State nothing, it

being economically remunerative. But if I had been enabled to have obtained the visit of the Crown Prince to the Norwood school when he was staying at the Norwood Hotel—he was prevented by the commencement of his fatal malady—I might have shown him that even better results are now attained and attainable on the half-time principle in large educational institutions on that principle. In them, in the juvenile stage, a military drill is imparted in that stage superior to any that can be imparted in the adult stages of life. In that juvenile stage industrial aptitudes are imparted which give to every two the industrial aptitudes and efficiency of three; which obtains for them on their leaving, at about thirteen years of age, 8s., 10s., or 12s. a week in wages, the former wages of adults. I could have also proved, that all the industrial, military, and combined industrial training in the adult stages, may now be better accomplished in juvenile stages of life. This is an important thesis for physical learning in national education, and shows the productive value of all that are born if they are properly trained.

Since last we met, there have been, as it appears to me, most important advances made in the improvement of ventilation. In some district institutions stoves have been introduced, which bring in constant supplies of fresh air, warm it, circulate it, and carry out the vitiated air. Dr. Richardson, in his own large library, has used one, a "Calorigen," which introduces fresh air, warms it, and constantly discharges the vitiated air, keeping the room all over at the temperature he desires. Sir Spencer Wells informs me that he uses one for each bedroom. In one hospital some forty are used. But Dr. Bond, the eminent inventive Health Officer of Gloucester, has invented one to which the Sanitary Institute has given a prize, as for a very material improvement, and now comes out another, adapted to large edifices, used and approved by General Webber, and worked by Mr. Green, the material part of which was invented by Mr. Maxim, the great American inventor of the new army gun. I have had the working of this stove examined at the new Courts of Justice, and it is reported to be completely satisfactory, and also on shipboard at the German Lloyds. It appears to be well adapted for the large schools, where the states of the atmosphere are denoted by the fact that the death-rates amongst the teachers are fourfold those of the Royal Navy on the home stations.

The next invention for sanitation since our last Congress here is of machinery for personal washing. A French colonel ascertained that he could wash his men with tepid water for a centime or a tenth of a penny per head, soap included. The man undresses, steps into a tray of tepid water, soaps himself, when a jet from a two-handed pump plays upon him tepid water, and he dries and dresses himself in five minutes, against twenty minutes in the bath, and with five gallons of water against some seventy in the usual bath. In Germany they have an arrangement devised by Mr. Grove, too long to describe, under which half a million of soldiers are now regularly washed, no doubt with the result by this important sanitary factor of the reduction of their army death-rate beyond any in Europe. I obtained the aid of Mr. (now Sir) Henry Doulton to direct inventions for some apparatus, specially applicable to schools; and he has got some in which it is proved that a child may be completely washed in three minutes. I have long put forth the fact of the economy of cleanliness—that a pig that is washed puts on a fifth more of flesh with the same amount of food than a pig that is unwashed; and I have had abundant evidence that the holy doctrine of "wash and be clean" is even more economical for children and men. Look at the comparative sanitary result of the washed children, of a whole school, as against the common one of the fouled-aired and badly-washed children. Look at the service to the poor mother who has no means of washing her children at home.

Added to this economical service is the new and great provision of the halfpenny dinners, which are remunerative. In sanitary science the true progress may be said to be in the little, and advances must be made in well-examined details. Such, however, as are now attained give the assurances of a great future for populations. Such as are now attained, if applied, will effect a conservancy of life and force, and of productive power heretofore unknown. They will prevent slaughters greater than any inflicted in modern wars; greater than was inflicted on France up to Sedan; greater than was sustained by Germany in their infliction; greater even than was sustained by the United States in their terrible civil war. But setting aside the consideration of such losses, setting aside the pains and misery of preventible excessive sickness., of premature mortality and sudden deaths, sound sanitarians may now pose as solely for the saving of money as Plutocrats. There is yet another great promise of sanitation, of the abolition of the foul soot and sooty fogs, and the reduction of the clothes-washing bill of the metropolis, which I estimated twenty years ago at £6,000,000. At Pittsburg, N.Y., the steam-power is worked by gas. In Manchester the working of steam-engines by gas is now offered at two-thirds of the price of working them by the wild flame of coal; and when the municipality has charge of the gasworks they may supply the houses with the internal apparatus and heating power at a rent cheaper than warming by coal. There is also promise of the extensive distribution of power by electricity. Experiments recently made at Oerlikon, near Zurich, have demonstrated the possibility of distributing power economically by means of electricity. The power of a water-wheel at Kriegstetten has been delivered at Solothurn, distant about five miles, and the net power delivered amounts to 75 per cent. of the power supplied by the water-wheel. Let me stay for an illustration due to Brighton itself. I have obtained a return, which we must press to

have got out for the information of all cities and places. This return vindicates the high position of Brighton as a health resort for the few. For the few — gentry and professional persons—the death-rate of children is only 8·93 of children under five years of age. But for many of the wage classes the death-rate of children under five years of age is 45·44. For the few the mean age of death of all who die—men, women, and children—is sixty-three years, a very high average, and befitting a health resort, but for the many, the wage classes, it is only 28·8. Of the few the proportion per cent. of those who attain and die of old age alone—of males it is 13·33; of females it is 14·93; but of the wage classes—it is of males only 3·59; of females, 5·25. I am convinced that the death-rate may be reduced here by at least 5 per 1,000; the rate, which is now 17, may be reduced to 12 per 1,000. Since our last Congress, there has by partial efforts been a reduction of 2·1 per 1,000, or a saving of 248 lives each year, which at Dr. Farr's estimate of the value of each life, gives a money saving of £39,432 each year. But if the mortality be further reduced to 10 per 1,000, as I am convinced it may be by thorough sanitation, the annual saving of lives will be equal to 1,064 in the year, and in money to £169,176 on the present estimated population. Sir Robert Rawlinson prepared a plan for the sanitary improvement of Brighton, correct in principle, which would have effected a large reduction of the death-rate, at an expense of some hundred thousand pounds for the entire outlay, payable by instalments in thirty years. Unfortunately, the plan was not well expounded, and was set aside for another which has proved to be a disaster, nearly as bad as that which has befallen the metropolis.

In the means of supplying water to urban districts considerable advances have been made. Clark's process for softening hard water when first introduced did not succeed in softening it below eight degrees of hardness. But since then modifications of the process have been introduced, by which the hard chalk water may be reduced to two and a half degrees, or to two degrees; and by which the whole of the hard water supplies of the metropolis may, when it is got under unity of administration, be advanced to the quality of the soft springs derived from granite sources. Three-fifths of the water now pumped into the metropolis is pumped to injurious waste, and has to be pumped out again. This waste may now be prevented by improved meterage.

The work of land drainage may now be executed on a large scale much cheaper and quicker by recently improved machinery than by spade labour, and considerable alterations will be required in the official instructions originally issued on this subject.

Of the chief provisions of the new Local Government Act I may treat at another opportunity. I would only now advert to some of them in their more hopeful aspects. The enlargement promised of many of the areas of local administration, with some securities for sanitary qualification, offer new opportunities, which may conduce to improve local organisations. If due exertions be made to inform the electors of their paramount interests in our work, they may be led to make a new and clear start, rejecting the sordid owners of bad tenements, those who go in solely for contracts among persons whose interests are adverse to a correct administration, and those who continue the enormous wastefulness of ignorance. If it be duly impressed on the wage classes that a large proportion of the £24,000,000 which they pay annually for insurance charges against excessive sickness and mortality may be saved by the efficient administration of sanitary science, we may expect large additions to our demonstrations of the power of those classes. But it must be admitted that, despite of the flagrant examples of the working of vestries, in the hurry of legislation large opportunities have been left for the continuance of the error. Before the close of the Session, however, opportunities may be afforded for correction; that is, if the promises made of a due recognition of our science, and of the position due to them, be not longer withheld. Great are our truths for the benefit of humanity; and let us hope that their general application will not be left exclusively for other men in after times. Let us hope that our old England may be the mother of sanitary blessings as well as colonial possessions, and that the local authorities in our Colonies, and our brethren in the United States, will invite competition of plans expressly for the reduction of death-rates. They will thereby direct study in a most profitable direction, and will inform themselves and their constituents what sanitary science may now do, and the vast economies it may effect for them, whilst they will, by such information, protect themselves from the quackeries and the continued wastefulness of ignorance in imperfect works, exclusively perpetrated without the attainment of any commensurate sanitary results.

INTERNATIONAL CONGRESS ON INLAND NAVIGATION.

The first congress, due to the initiative of M. A. Gobert, Ingénieur Honoraire des Ponts et Chaussées of Belgium, sat at Brussels in 1885, and was referred to in this *Journal*. The second was held the following year at Vienna, when double the number of members assembled; and on 20th August the third international congress was opened in the Saal-bau, Frankfort-on-Main, by the Minister of State, Von Bötticher, who welcomed the members in the name of the German Government and of the Emperor, William II., patron of the Frankfort Congress. No less than 712 members were enrolled by the opening day, making about double the number that met at Vienna, and therefore quadruple that at Brussels;

and so many members gave in their names as intending to be present at the Manchester Congress two years hence, as to warrant the supposition that the same progressive increase in the number of members will be maintained. This circumstance, and the fact that the Frankfort Congress had quite an official character, shows the interest taken in this important question.

The programme before the Frankfort Congress consisted of six questions on the following subjects :—

I. Inland navigation statistics, with papers by Dr. Arthur von Studnitz, Dresden, and N. Sytenko, St. Petersburg.

II. Improvement in the navigability of rivers; and papers by Professor T. Schlichting, of Charlottenburg, and Ernst Wallands, of Buda-Pesth.

III. The best types of steam-tugs on inland waterways :—Papers by Prof. Carl Dill, Berlin, and P. A. Melchers, Maintz.

IV. Economical condition of inland ship canals :—E. Leader Williams, C.E., Manchester, and A. Gobert, Ing. Hon. Ponts et Chaussées, Brussels.

V. Advantages accruing to agriculture by regulating rivers and making canals :—Papers by Oberbaurath Hagen, Berlin; Ober-regierungsrath Thiel, Berlin; Ingénieur-en-chef De Mas, Auxerre; and Léon Philippe, Directeur au Ministere de l'Agriculture, Paris.

VI. The rendering navigable and maintenance of estuaries :—Papers by Ober-baudirector L. Franzius, Bremen, and Prof. Osborne Reynolds, Manchester.

There were twenty English members, including Mr. Courtenay Boyle, Assistant-Secretary to the Board of Trade, delegated by the British Government; Hon. P. Stanhope, M.P.; L. F. Vernon-Harcourt, M.Inst.C.E.; James Duncan, Chairman of the Railway and Canal Traders' Association; Marshall Stevens, Manchester Ship Canal Co.; and Alderman Emden, York, one of the Ouse Commissioners.

The members were divided into three sections, for the consideration of the above-named subjects, and their conclusions or resolutions were afterwards submitted to the whole Congress, which held four general meetings. The following is a *résumé* of the results arrived at, taken for convenience in the order of the questions.

With respect to the First Question, Dr. A. von Studnitz, who brought up the report of the 3rd Section, proposed :—

1. In order to properly work navigable waterways, it is desirable to have (*a*) an exact description and graphic representation of navigable waterways, and all that relates to their working, with an estimate of the cost of construction and maintenance; (*b*) a description and inventory of vessels navigating the several navigable waterways; and (*c*) statistics relating to the traffic of navigable waterways in tons per kilometre, so as to permit of a thorough comparison with railway traffic.

2. In order to carry out the above proposition, a commission shall be formed from among the members of the Congress, one for each State represented. This commission, which shall have the right to add to their number as many supplementary members as may be necessary, shall meet without delay, in order to draw up a report to be submitted to the next congress.

This was carried, with the exception that the first proposition was made to open as follows :—"With a view to obtain practical statistics as to inland navigation, it is necessary, &c.," and "permit" in 1 (c) was altered to "render possible." A large number of members took part in the discussion, and ultimately an International Commission on Inland Navigation Statistics was formed.

The members of this commission were charged to obtain, if possible, the confirmation of their appointment by their respective governments, in order to give their labours an official character, and to send all the details possible connected with the subject to the Central Statistical Bureau at Berlin.

Prof. Schlichting brought up the report of the first section on the second question. Resolutions were carried as follows :—

1. The results hitherto obtained by the regulation and canalisation of rivers have caused a notable accession of inland navigation traffic, and have thus increased the economical value of these waterways.

2. The constantly increasing need of communication, as well as the interests of national economy, may claim further improvements, in the still deficient navigability of rivers, and their navigation works.

3. It is thought necessary (*a*) to determine, by means of new hydrotechnical researches, the highest limit of navigability attainable for all such rivers, in which normal widths, empirically accepted long ago, are still maintained; (*b*) to strive, by means of experiments and observations in water-courses, and in trial stations especially arranged for the purpose, to promote hydrotechnical science, and to improve the constructions concerning navigation.

On the third question coming on for discussion, under the presidency of Dr. Russ, of Vienna, Prof. Dill declined to present the report of the section, which was accordingly done by Signor Rigoni, who pointed out the difference of opinion in the section, and ultimately proposed the following resolution :—"That practical and scientific experiments be made in order to ascertain the most suitable forms and proportions for boats used in the great traffic on inland waterways; that these experiments be carried out under the direction of the governments interested in the progress of inland navigation, and according to a uniform system to be previously agreed upon; and also the best means of propulsion, either forming part of the boat or independent of it, which best fulfil the conditions of speed, regularity, and cheapness."

This was opposed by Dr. Strohler, of Berlin, but supported by Director Philippi, of Dresden, and M. Raffalovich, of St. Petersburgh, but ultimately

carried on the motion of Signor Rigoni. On the motion of Herr Oelwein, President of the Section, M. Captier's motion that the question of tolls on navigations should be included in the programme next Congress, and at the wish of several French members, that of dues at inland ports was added. A proposition by Mr. Courtenay Boyle, that the questions of canal tariffs, and the classification of goods for tariff, be included in the programme of the next congress was also carried.

As to the 4th question, "Under what conditions is the construction of canals for bringing ocean-going vessels to inland ports justified from an economical point of view?" coming on for discussion by Section II., the reporter, Engineer A. Gobert, of Brussels, submitted the following conclusions:— "When the ratio between the traffic expressed in tons, and the cost of construction per kilometre expressed in francs is two to one, or greater, then there is utility is making a ship canal in the sense of its being a paying concern, because the cost price on the canal is so low that the resulting economy leaves a very large margin for indemnifying at need the parallel railways for eventual losses that the canal may cause them by diminishing their traffic." As an amendment to this, Herr Franzius proposed that, "While the Section is not in a position to check M. Gobert's figures, it declares itself in agreement with the views expressed in his report." This was carried, and afterwards endorsed by the whole Congress.

With respect to the 5th question, as to the utility to agriculture of cutting canals rendering rivers navigable, Herr Hagen, of Berlin, arrived at the the following conclusions, which were unanimously adopted by the Congress:—1. The regulation of rivers, apart from facilitating the transport of raw products and manufactures is of the greatest advantage to the agriculturists, as it not only fixes the course and preserves the banks, but it greatly diminishes the risk of blocking by ice. 2. In canalising rivers and making canals, all possible attention should be given to the improvement of the adjacent lands as far as this is possible, without detracting from the main objects of the works, the formation of a convenient waterway. With this object, in elaborating the schemes and projects, great importance should be attached to the influence of the works both surface and underground, and care must be taken of the extent to which the requirements of agriculture may be satisfied. 3. In the interest of the development of local agricultural transport, it is desirable to facilitate as far as possible land access to the waterway.

The 6th question, as to rendering estuaries navigable, formed the subject of the following four propositions by the reporter, Herr Franzius, of Bremen:—

1. It is in every way advantageous to bring ocean-going vessels as far inland as possible; the most favourable conditions under which this can take place are offered by a river that is navigable for river-boats above the point of its course attainable by ocean-going ships. Hence the importance of rendering estuaries navigable.

2. The utility of estuaries for navigation purposes is more dependent on the presence of considerable flood and ebb tides than on the size of the river. Generally stated, the larger a river and the greater the amount of matter it carries in suspension, the greater must be the tidal fluctuation in order to prevent the formation of banks detrimental to navigation.

3. Estuaries without marked tidal fluctuation can in most cases only be rendered navigable by narrowing in and keeping together the fixed and non-increasable amount of flow in all reaches where the formation of branches or deltas is to be feared, and by then carrying it out to deep water between training banks or jetties. Should a natural lagune, haff, or the like—separated from the sea, and filling and emptying under the influence of varying winds—exist close above the lowest reach, or at the point where the river proper flows into the estuary, this can be utilised for obtaining a greater depth for the lower reach (the estuary proper) than is attainable above.

4. Estuaries having high tides are to be rendered navigable by increasing quantity and velocity of the tidal column as far as possible. The estuary proper, considered from tide-end to the open sea, should therefore regularly increase in breadth in the shape of a funnel. The average velocity, however, in the main stream or in the low-water channel, must not be permitted to diminish for fear of the formation of a bar. The low-water channel should be uniform, carried along on bold lines, and as far as possible bounded on each side by a low training-wall. On the other hand, large surfaces should be reserved for the reception of flood water during high floods.

The section, fully appreciating the justice of the arguments of the reporter, declared itself in agreement therewith, and this was also endorsed by the congress at the general meeting.

CANES AND STICKS USED IN THE MANUFACTURE OF WALKING STICKS, UMBRELLA HANDLES, &c.

By J. R. Jackson, A.L.S., &c.

Part I.

There are few trades probably that have developed so rapidly as that which has for its operations the conversion of rough sticks of all kinds into fashionable walking sticks, umbrella and sunshade handles. Forty—or even twenty—years ago, but little was known about the trade, and even now few people have the slightest notion from whence come the sticks they carry, or how they are manipulated into the very many varied forms we now see.

At the early date mentioned above, the stock-in-trade of a walking-stick maker was very limited. Amongst English produce, the ash and oak were the principal sticks used, while foreign sticks consisted of partridge and Tonquin canes and bamboos. At the present time there is, comparatively speaking, no limit to the material that can be turned to account for the purpose of walking and umbrella stick making; indeed there is always a keen look out being kept up for new sources of material, and a constant introduction of novelties, both in the sticks themselves as well as in the adaptation of them to meet the demand of fashion. So great, indeed, and so varied and numerous are these demands, that of late years, especially in continental countries, many persons have taken up with the cultivation of sticks of certain kinds, exclusively to supply the walking-stick market. In this country land is generally of too high a value for it to be placed under such a system of culture, though quite recently large quantities of ash saplings, in which the roots have all been directed in one way to form what is known as cross-heads, have been grown in the county of Surrey.

Nearly twenty years ago the first collection ever got together illustrating the materials used for walking sticks was presented to the museum of the Royal Gardens, Kew, and quite recently this collection has been entirely revised and augmented by the same firm which originally presented it, namely, Messrs. Henry Howell and Co., of Old-street, St. Luke's. I am indebted to these gentlemen, not only for giving me permission to inspect their factory, and for much information contained in this paper, but also for their kindness in furnishing reports on any new materials that have from time to time come under our notice at Kew.

To give an idea of the extent of the work carried on, I may mention that the floor space of the factories cover an area of nearly an acre in extent, and that over 400 workpeople are employed, about 50 of which are occupied in gold and silver mounting. The buildings devoted to the storage of the raw materials are necessarily very extensive, and consist of four floors, on which are classified the various English and foreign sticks as they are imported or brought in from the home forests, and although the thousands upon thousands of sticks here deposited have all been carefully and individually selected for the purposes of the trade, they appear, in the bulk, more suited for firewood than for any other purpose. Forest produce from all parts of the world are here deposited. From the East and West Indies, Singapore, Java, China, and other eastern countries, are derived a great variety of sticks, principally, however, belonging to the bamboo and palm tribes. The sticks, as required for the workshops, are drafted from these immense stores; some are so crooked, that they require a great deal of straightening before anything else is done with them, and this straightening process is one of the most interesting and remarkable. On the top of a very hot stove is a heap of sand, in which the sticks are plunged, and kept there till they have become quite pliable. The workman then takes the crooked stick while it is still hot and inserts it into a notch cut in a stout board, placed at an angle inclined from him, and bends and strains it, occasionally casting his eye along it to see that it is straight, and when perfectly so it is thrown down to cool, and when cold it is quite rigid, without the slightest fear of it ever going back to its natural crookedness. In this way some of the most irregular and apparently worthless sticks are made to assume an appearance almost impossible, when we consider that the workman has nothing but practice and a well trained eye to guide him. Heat is a very important element in the manipulations of a stick-maker, and produces very different effects on the several kinds of woods, the degree of heat necessary to straighten one kind of stick being often sufficient to completely spoil another kind. The same power which makes a crooked stick straight is applied to make a straight one crooked, and so we find that the rigid stems of bamboos, partridge canes, as well as all the various kinds of English sticks which are required to be curled or twisted, are by the application of heat made to assume almost any shape or form. Thus we often see ladies' sunshade handles at the present time, especially those of bamboo or partridge cane, twisted and even tied into double knots.

By far the largest number of sticks used are those known as natural sticks, that is saplings of trees or climbing plants, where the roots have sufficient character to form handles or knots. These are always more in demand, whether for walking, umbrella, or sunshade sticks, than those that are cut from the solid-like letter-wood, ebony, boxwood, beef-wood, partridge-wood, &c. Messrs. Howell, with the view of bringing to light undeveloped resources of which they express themselves as confident that a large number still exist, especially in the Eastern and South American forests, have had some notes drawn up and circulated amongst their correspondents in all parts of the world. These notes are as follows:—

"Points to be observed in collecting raw sticks, canes, &c., for walking sticks, umbrella handles, &c. The total length should not be less than 42 inches, end to end, but if possible they should be 48 inches.

The best sizes are of the diameter of half-inch to one inch measured about midway, they should not be larger than one and a quarter inches in diameter.

It is indispensable that the diameter should gradually diminish from the root, or handle, to the point, so that the stick is not 'top-heavy.'

It is always bettter, when possible, to send sticks with some kind of handle; if the plant be pulled up the root should be left quite rough and untrimmed; if a branch be cut off, a part of the parent branch should be left on to form a knob or crutch handle. Sticks without handles can be used, especially if they are nicely grown and have any peculiarity of struc-

ture or colour; but if there is any handle, however small, it should not be cut off. Young saplings of the different kinds of palms, bamboos, &c., should always have the root left on. Occasionally the form of the root or handle part is attractive, while the stick itself is weak and defective in such; cases the handles only should be sent, and they should measure from 15 to 18 inches in length.

In sending specimens of new sticks, it is better to send only small quantities, say one or two dozen, at most, of each kind, then if approved, further quantities can be asked for.

Specimens of anything remarkable for form or colour, whether in the roots or stems of woody, herbaceous, or reedy structures should be sent, as sometimes the most unlikely things are found to possess value for use either as umbrella handles or walking sticks."

It will be seen from these notes that, as before stated, the chief demand is for natural sticks, many of which lend themselves readily to the varied designs so necessary for ladies' sunshades. Not many years since the whole of the machinery in use was worked by hand, but in consequence of it being necessary to turn out very large orders with great rapidity, steam power was introduced, which sets in motion band and circular saws, planes, and rasps, with the result that a stick of the toughest description can be converted into a marketable article in a very short time. So dexterous do the workmen become in the use of these tools that they seldom make even the slightest error in their work, and the rapidity with which the workers in gold and silver mounting perform their delicate manipulations is remarkable. Besides the precious metals a great variety of valuable stone mounting is effected in this department, amongst the stones used being Mexican onyx, agate, jasper, various marbles, and occasionally even the more precious stones, including diamonds. Ivory, horns of all kinds, rhinoceros, buffalo, stag, seahorse, walrus tusks, &c., are also largely used.

TEA CULTIVATION IN ASSAM.

The following information relating to tea culture in Assam for the year 1887 is extracted from the last Annual Report of the Secretary to the Chief Commissioner of Assam to the Secretary to the Government of India, Revenue and Agricultural Department:—

"In accordance with a suggestion made by the Commissioner of the Assam Valley Districts, figures have this year been furnished separately for each subdivision, in addition to the totals for each district, as in former years. Of the subdivisions Silchar has most gardens (135), and produces most tea (14,000,168 lbs.). Of outlying subdivisions Jorhât has 63 gardens, while South Sylhet, with 50 gardens, has the out-turn of 7,198,822 lbs., which is more than is produced by the remaining subdivisions of Sylhet taken together, or by any but the four largest tea districts.

"The returns show 873 gardens on the registers at the end of 1887, a decrease of ten on the number in 1886. One new garden was opened in South Sylhet, one in Tezpur, and one in Mangaldai. Thirteen gardens were removed from the registers. Amalgamations were fewer than in previous years, when much was done in the way of amalgamating concerns with a view to economy and convenience of working. The causes of removal were as follows:— In Cachar one garden closed, in Sylhet one amalgamated, in Sibsagar three gardens closed and three amalgamated, in Lakhimpur five gardens closed.

"The area of land held by tea planters in the district of Cachar was 234,939 acres, a decrease of 23,083 acres, as compared with the preceding year; in Sylhet, 175,138 acres, an increase of 22,732 acres; in Khasi and Jaintia hills, 80 acres; in Goalpara, 1,338 acres, an increase of 1 acre; in Kamrup, 25,361 acres; in Darrang, 103,880 acres, an increase of 3,534 acres; in Nowgong, 59,702 acres, a decrease of 915 acres; in Sibsagar, 221,912 acres, an increase of 19,387 acres; in Lakhimpur, 127,821 acres, a decrease of 5,619 acres; giving a total for 1887 of 950,171 acres, representing an increase over 1886 of 16,037 acres.

"In Cachar the large apparent decrease is due to the substitution of the area shown in the tea-garden register for that of tenures of all kinds, including grants which did not form part of any garden, which latter total was shown in the reports for 1883 and later years. There was actually an increase of 768 acres newly taken up. In Sylhet the increase is due to the receipt of more complete returns from managers, and is apparent rather than real. In this district, as an exception, managers' figures of area are shown, as the area reported as actually under tea in 17 gardens is greater than that shown in the tea garden registers, which are incomplete as regards land not held directly from Government.

"In Darrang the increase is due to the opening of new, and additions to old, gardens. In Nowgong the decrease in the area held is explained by resumptions, resignations, and re-survey. In Sibsagar the Deputy-Commissioner explains that the increase is due to figures other than those of the tea-garden registers having been shown for Jorhât and Golaghat last year. In Lakhimpur the decrease is due to relinquishments of land, readjustments of boundaries, and the closing of gardens.

"For 822 out of the 873 gardens in the province, the managers or agents furnished figures; for 47, figures were estimated by the Deputy-Commissioners, last years figures being taken when available; and for four gardens no information was forthcoming. The statistics are based to a greater extent on in-

formation supplied by tea-planters, and are, therefore, more complete than in any previous year. In Cachar and Sylhet the improvement is partly due to the later submission of the reports. In Sylhet information was given for 109 gardens, as against 96 in 1886.

"The statement given below shows the figures for the last six years of the land actually under tea cultivation, and also the total area held by tea-planters:—

Years.	Under Mature Plants.	Under Immature Plants.	Total Area of Land held by Tea-planters.
	Acres.	Acres.	Acres.
1882	156 707	22,144	783,362
1883	161,707	27,746	923,664
1884	158,1[illegible]8	31,694	913,476
1885	159,876	37,634	915,846
1886	170,138	33,855	934,134
1887	177,900	33,179	950,171

"The increase in area under mature plants (7,762 acres) occurred mainly in Sylhet (5,136 acres). Of this 1,921 acres is nominal. Assuming the correctness of the other figures, 5,841 acres passed from the area of immature to that of mature cultivation. These were replaced by extensions amounting to 5,165 acres, leaving 676 acres less under immature plants at the end of 1887 than in the previous year.

"The total area under cultivation in 1887, both of mature and immature plants, was 211,079 acres, being an increase of 7,086 acres over 1886. Of this total Cachar comprised 54,995 acres, a decrease of 840 acres; Sylhet, 40,082 acres, an increase of 5,364 acres; Khasi and Jaintia hills, 30 acres; Goalpara, 394 acres; Kamrup, 6,909 acres, an increase of 497 acres; Darrang, 19,370 acres, an increase of 875 acres; Nowgong, 11,303 acres, an increase of 463 acres; Sibsagar, 47,566 acres, an increase of 670 acres; and Lakhimpur, 30,430 acres, an increase of 57 acres.

"The total out-turn of tea grown in the province is reported as 68,451,180 lbs., an increase of 6,731,502 lbs., or 10·91 per cent. on the figures for 1886, and more than double the out-turn of 1880. The increase has been steady of late years, except in 1884, when there was a small falling off. The Indian Tea Association put the actual out-turn of the crop of 1887, for Assam, Cachar, and Sylhet, at 65,005,791 lbs., nearly 3,500,000 lbs. less than the district figure. According to the Tea Association's figures, the province of Assam produced 74·89 per cent. of the whole crop of Indian tea in 1887.

"The district of Cachar had a total yield, in 1887, of 16,556,298 lbs., a per-centage increase of 10·65 lbs. over 1886; Sylhet produced 12,715,763 lbs., an increase per cent. of 36·77 lbs.; Khasi and Jaintia Hills, 3,000 lbs., 87·50 lbs. per cent. increase; Goalpara, 94,998 lbs., or ·08 lb. per cent. decrease; Kamrup, 1,136,410 lbs., or 22·30 lbs. per cent. increase; Darrang, 6,886,661 lbs., or 29·26 lbs. per cent. increase; Nowgong, 3,346,958 lbs., or 7·70 lbs. per cent. increase; Sibsagar, 14,699,193 lbs., or ·66 lbs. per cent. increase; and Lakhimpur, 13,011,899 lbs., or 2·87 lbs. per cent. increase.

"The yield per acre for the whole province was 385 lbs. in 1887, as compared with 363 lbs. in 1886.

"The imports of tea-seed reached 102 maunds in 1887, against 454 maunds in 1886; the exports totalled 5,655 maunds in 1887, as compared with 2,416 maunds in 1886."

The report affirms that, with improved communications, cheaper labour and improved methods of cultivation and manufacture, the cost of production tends to decrease. In illustration of this view the opinion of a leading planter in Cachar is quoted:—

"It is a curious fact that, although the price of tea is now lower than ever known before, still most of the tea concerns did fairly well as regards profits over the year's working. The explanation is, that the tea can now be turned out for less than what was possible a few years ago. The use of machinery of an improved character is now largely extended, with the invariable result that everything is done cheaper, while freight and cost of transport is much less. Then, coolies are growing older and more skilled in their work, and can do more and far better than they could when raw hands; while all extensions made upon gardens are put out with the best class of plant available, upon good soils, carefully chosen, and these parts, as they come into bearing, produce a far bigger out-turn per acre than the original parts of the garden."

In the current year, according to the estimate prepared by the Indian Tea Association, it is anticipated that Assam will produce 70,975,884 lbs. out of an Indian crop of 95,829,312 lbs.—*Board of Trade Journal.*

PETROLEUM DEPOSITS IN VENEZUELA.

Part of the Department of Colon situated between the rivers Santa Anna, Zulia, and the Sierra of the Columbian frontier, is very rich in asphalte and petroleum. The United States consul at Maracaibo says that the information available regarding this extensive and interesting section, which is an uninhabited forest, is derived chiefly from the reports of the searchers for *Balsam copaiba*, which abounds in this region. Near the Rio de Oro, and at the foot of the Sierra, there is a very curious phenomenon, consisting of a horizontal cave which constantly ejects, in the form of large globules, a thick bitumen. These

globules explode at the mouth of the cave with a noise sufficient to be heard at a considerable distance, and the bitumen, forming a slow current, falls finally into a large deposit of the same substance near the river bank. The territory bounded by the rivers Zuilia, Catatumba, and Cordillera is rich in deposits, and flows of asphalte and petroleum, especially towards the south, where the latter is very abundant. At a distance of little more than four miles from the confluence of the rivers Tara and Sardinete, there is a mound of sand of from twenty-five to thirty feet in height, with an area of about 8,000 square feet. On its surface are a multitude of cylindrical holes of different sizes which eject with violence streams of petroleum and hot water, causing a noise equal to that produced by two or three steamers blowing off simultaneously. For a long distance from the site of this phenomenon the ground is covered or impregnated with petroleum. The few explorers for *balsam copaiba* who have visited this place call it the *infernito*, or little hell. It is stated that from one only of these streams of petroleum was filled in one minute a receptacle of the capacity of four gallons, which for one hour would be 240 gallons, or 5,760 gallons in 24 hours. This petroleum is of excellent quality, with a density of 83 degrees, which is a sufficient grade for foreign markets. Consul Plumacher says that, considering the immense amount of inflammable gases which must be given out by the flows and deposits of petroleum, it may be easily believed that this has a direct bearing upon the phenomenon known since the conquest as the *Faro* of Maracaibo. This consists of constant lightning without thunder, which may be observed towards the south from the bar, at the entrance to the lake, and which Codazzi, in his geography, explains as being caused by the vapours arising from the hot water swamps situated about a league to the east of the mouth of the Escalante River, at the southern extremity of the lake. In the department of Sucre, at the foot of the mountains, are found various croppings of asphalte and coal. Near the mountains, and not far from the river Torondoy, there are various flows of a substance which appears to be distinct from either asphalte or petroleum. It is a liquid of a black colour, with little density, and strongly impregnated with carbonic acid, and its apparent identity with a substance met with in the United States among the great anthracite deposits, leads to the belief that there also may be discovered formations of that valuable mineral. The State of Zulia, in which deposits of coal, asphalte, and petroleum are situated, is as yet free from any monopolistic concession; but this, in Consul Plumacher's opinion, cannot last for ever. In conclusion, Consul Plumacher adds that the Government is disposed to extend every reasonable encouragement and protection, and at the present time European corporations are drawing large incomes from the capital which they have had the courage to invest in Venezuela.

Obituary.

William Muir.—Mr. Muir, the mechanical engineer, of London and Manchester, who died at his residence at Brockley in June last, had been a member of the Society of Arts for over thirty years. He was born at Catrine, in Ayrshire, on January 17, 1806, and commenced his business career as an apprentice to Mr. Thomas Morton, of Kilmarnock. After serving with several firms in Scotland, he came up to London in 1831, and entered the shops of Messrs. Maudslay and Field, where he soon became a foreman. He then went to Messrs. Holtzapffel's, and afterwards to Messrs. Bramah and Robinson. In 1843 he went to Manchester as manager of Mr. (afterwards Sir Joseph) Whitworth's works. Subsequently he assisted Mr. Thomas Edmundson, the originator of the railway ticket, in the production of machines for printing the tickets, and founded the firm with which his name is associated. The firm was awarded a bronze medal in 1855 for an improved grindstone, exhibited at the Society of Arts Exhibition of Inventions; and Mr. Muir was elected a member of the Society in 1856.

General Notes.

Exhibition of Wheels at Leipzig. — The *Glasers Annalen für Gewerb und Bauwesen* states that an exhibition of wheels and parts of wheels will be held at Leipzig, in the month of February, 1889. Applications for admission will be received until the 30th of September inst., by Th. Weber, Leipzig. The locale of the exhibition is already secured.

The World's Silk Production.—The following statement, which has been extracted from returns lately prepared by the Syndicate of Silk Manufacturers of Lyons, shows the world's silk production in each of the years 1884, 1885, 1886, and 1887, the figures being in kilogrammes (one kilogramme = 2·204 lbs. avoirdupois):—

	1884.	1885.	1886.	1887.
	kilos.	kilos.	kilos.	kilos.
France and Spain	568,000	591,000	729,000	800,000
Italy and Austria	2,952,000	2,625,000	3,405,000	3,750,000
Total for Europe	3,520,000	3,216,000	4,134,000	4,550,000
Levant	730,000	623,000	677,000	730,000
Exports from—				
Shanghai	2,695,000	2,631,000	2,444,000	2,450,000
Canton	774,000	715,000	1,110,000	1,080,000
Yokohama	1,346,000	1,372,000	1,484,000	2,100,000
Calcutta	861,000	760,000	781,000	800,000
Total for Eastern Asia	5,676,000	5,478,000	5,819,000	6,430,000
Total production	9,926,000	9,317,000	10,630,000	11,710,000

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CANTOR LECTURES.

YEAST; ITS MORPHOLOGY AND CULTURE.

By A. Gordon Salamon, A.R.S.M., F.I.C., F.C.S.

Lecture I.—Delivered January 30, 1888.

The responsibility ordinarily connected with the delivery of a course of scientific lectures is, in this instance, materially increased by the knowledge that I am following in the footsteps of Professor Graham, to whose Cantor lectures, delivered in this theatre, we can, without doubt, trace the first impulse—the first legitimate incentive—to an extended study in this country of the theoretical aspects of the art of fermentation.

Those lectures, however, may fairly be said to have been delivered during a revolutionary period in the history of the science. When Pasteur developed his theories respecting fermentation in explanation of his experiments, he was forthwith involved in a storm of controversy which took years to subside. Indeed, it was not until calm and deliberate judgment had decided the value of his work, that it was deemed sufficiently substantial to constitute the stepping stone to further studies. The majority of these had scarcely been instituted when Professor Graham first urged the necessity of correlating theory and practice. But they are now complete, or, at any rate, sufficiently advanced to allow of their significance being appreciated. It is, therefore, advisable to pass them in review, with the object of grasping the philosophy of their bearing, of seeing what influence they may be capable of exerting upon the economics of fermentation, and of indicating, if possible, the direction in which subsequent research will tend.

If we desire to make a minute examination of any substance, and to gain an accurate knowledge of its properties and composition, we must investigate it in its simplest and purest form. Applying this axiom to the study of yeast, we have to prepare it in a much less dense condition than that in which it is employed for commercial purposes. We have, as is well known, to dilute it to such an extent that it conveniently admits of critical observation under the lens of a microscope. We then find that the pasty mass, which brewers are accustomed to handle in bulk, is composed of a vast number of more or less globular discs, for the most part wholly disconnected. We distinguish such discs by the name of cells. It is possible, as will be shown hereafter, to separate a single cell from a "crop" of "pitching" or other yeast, and to determine its properties when thus isolated. If such a cell be introduced under defined conditions into a medium which has been proved by experience to be suitable for the purpose, and if, whilst still in the medium in question, it be subjected to a continuous microscopic scrutiny, it will be noticed that the cell does not permanently retain the form which it originally possessed. In course of time a prominence or swelling, or it may be more than one, is observable upon the exterior of the cell. At first minute, it gradually increases, until it ultimately assumes dimensions very nearly similar to that of the cell itself. It remains the while attached to the cell, and if examined in this condition will be found closely to correspond with it in all its external characteristics. The attachment may then gradually be weakened, until at length that which was originally a minute protuberance becomes itself a detached and differentiated cell, similar in appearance to that which gave rise to it. In like manner the newly-formed cell may produce one or several others; and by a continuation of the process a sufficent number of cells may be formed to constitute a crop available for pitching purposes. Even more remarkable is it to find that the crop thus produced from the single cell has all the appearances of that used in commerce, and weighs as heavily, whereas the original cell which yielded the crop would not have deflected the beam of the most sensitive balance.

Thus, both by the method of analysis and of synthesis, we are led to the important, yet irrefutable, conclusion that yeast, as it is commercially known, is composed of countless numbers of cells possessing the same appearance, or at any rate so close a resemblance to one another as to make them practically identical, at least within the limits of casual microscopic inspection.

The medium in which this cell formation has taken place has itself undergone modification, and that of a most important character. Some, if not all, of its constituents have become decomposed; if the yeast crop be separated from the medium, it will be found that the latter has undergone a very considerable diminution in weight; heat, the recording index of chemical change, has been manifested; gaseous products have been evolved; and substances originally complex in composition have become resolved into other and more simply-constituted bodies. Moreover, it is capable of proof that, but for the presence of the original cell, this series of changes would not have taken place. We are justified, therefore, in attributing them to some influence or influences exerted by the cell and those which may have been formed from it during the progress of the various changes.

I have said that the single cell must, in order to exhibit and induce these phenomena, have been brought into a suitable medium, and under certain prescribed conditions: otherwise the results would have been totally different. If, for instance, the isolated single cell had not been introduced into any medium at all, had been deprived of moisture and of oxygen, it would not have developed protuberances upon its exterior; it would not have multiplied or caused an increase in the original weight of yeast; nor would it have retained its original structural appearance. It would, on the contrary, have become shrivelled in appearance and diminished in size, until it would ultimately have become unrecognisable as a yeast cell; and if after a certain interval of time, a very long interval it is true, it had been introduced into the medium adapted to cell multiplication, it would then have failed to produce a crop of yeast, or indeed a single yeast cell, neither would it have brought about the same decompositions in the medium, nor would it have itself increased in weight.

We see, therefore, that the yeast cell is not always capable of multiplication, and it is obviously of importance to ascertain the limits within which it is possible.

Among the earliest of the conclusions forced upon a student of natural science, and more especially upon one who has grasped the full meaning of the doctrine of evolution, is that which leads him to acknowledge that there are no absolute boundaries, no rigid lines of demarcation, between what are popularly recognised as the animal, vegetable, and mineral kingdoms. True enough, an animal, in the general acceptance of the term, is sufficiently distinct from a vegetable, as widely different indeed as the latter from a mineral; but closer observation shows that, in the world as we know it, there is an overlapping of the three divisions, or a gradual merging of one into the other. There are numerous instances among the lower forms of organised matter, in which it requires the skill of an expert to decide as to whether a body is an animal or a vegetable, and in like manner there are certain mineral substances which might easily be mistaken for vegetable matter. Each division has its general attributes, but there are cases in which the differentiation becomes obscured, and identification a matter of great difficulty.

The class of bodies to which yeast belongs falls within this category, and its true position in the realms of nature was consequently for many years involved in doubt and controversy. Indeed, even now there are some—a trifling minority, it is true—who deny the accuracy of the reasoning through which it has been assigned its present position in the accepted classification of aggregated matter. In ordinary circumstances there is but little difficulty in coming to a decision upon such a point. Broad and fundamental differences exist which are sufficiently typical and characteristic to bring the consideration within a comparatively narrow compass. For instance, in applying such tests to the case of yeast, the cell multiplication and its increase in weight at the expense of the medium in which it is placed, coupled with its decay and non-multiplication when placed in unsuitable media, amply prove that it is not a mineral. For such phenomena are clearly those associated with life, growth, reproduction, and death, and as such are absolutely foreign to any of the known properties of minerals.

It remains, therefore, to decide as to whether it is an animal or a plant. In this we are again assisted by reference to the typical conditions pertaining to the life of both. Now microscopic examination of a yeast cell shows that it is surrounded by an envelope

or sac of cellulose, and although there may be variations in the thickness of this envelope, there is reason to believe that it is continuous; in other words, that it does not exhibit orifices such as exist in animals for the introduction of food within the system, and for the excretion of products voided as the result of food assimilation; and further, since the single cell is capable of life and reproduction, it follows that the continuous cell wall and the contents which it encloses must constitute the whole machinery which is enabled to manifest these phenomena.

In the case of nearly all animals the food is conveyed into the system by means of an opening adapted to the purpose. Now with the yeast cell such a means of introduction is impossible, because of the existence of the continuous cell wall, which is unprovided with openings; and if the cellulose wall were broken, the life of the cell would be determined. It is therefore clear that the only way in which food can be conveyed into the interior of the cell is by passage through the cellulose. This is, indeed, what actually happens, and it is accomplished by means of diffusion or osmosis. We shall inquire further into the nature of this process at a later stage; for the present it will suffice to state that one of the conditions essential to diffusion through cellulose is that the substance diffused must be in a state of solution; hence it follows that no food can be assimilated by yeast unless it is previously dissolved.

These facts tend to prove that yeast is a plant, because a cellulose wall, and the passage of dissolved nutrient matter through it by osmosis, constitute two of the most essential conditions of plant life. But the conclusion is greatly strengthened, indeed corroborated, by other considerations dependent upon the chemical constitution of the food assimilated. Now animals and plants have this in common; apart from certain mineral elements, which, for the moment, we can ignore, they both require a supply, in some form or other, of the elements carbon, hydrogen, oxygen, and nitrogen. So, as far as information goes, these elements must be aggregated as certain molecular combinations before they can be regarded as nutrifying ingredients.

Among these combinations we recognise a group of complex nitrogenous bodies known as proteins. Their supply would seem to be essential to a normal, healthy, and continued existence both of animals and plants. Suitable animal food contains these protein bodies ready formed in a state available for assimilation, and proportioned in quantity to the climatic conditions and life history of the organisms by which they are consumed. If the animal did not find the protein nourishment ready made it would not be competent for it to manufacture it or build it up out of the elements of which it is composed. For instance, protein bodies are strictly organic compounds as distinguished from minerals, and it would not be possible for any animal to form protein out of mineral matters. This is not so with plants. They are possessed of the property of forming or manufacturing it from the elements or from true mineral substances, which latter they have the power of breaking down or decomposing in order that the requisite elements may be devoted to the purpose. This is found to hold good with all plants, but with no animals; and it therefore establishes a fundamental difference between the two which is sufficient to constitute a reliable test in case of doubt. Applying it in our own case, we find that yeast is possessed of this power of forming protein out of mineral substances. The point has been abundantly proved by Pasteur. He showed how millions of cells, each containing its requisite amount of protein, could be produced in a healthy and thriving state from a small number of parent cells by introducing the latter into a fluid of the following definite composition:—Water, sugar, ammonic tartrate, potassium phosphate, calcium phosphate, magnesium sulphate.

The growth of yeast in this fluid is accompanied by the gradual disappearance of the above-named constituents, and the formation in all the newly-developed yeast cells of protein bodies. The latter were obviously not present in the original fluid. It can be proved that the mineral substances present have not the power of forming them in the absence of the yeast or some other similarly constituted organism, and hence it follows that in this case they must have been formed by the yeast, and at the expense of the original constituents of the fluid. Moreover, the recent researches of Hansen have shown that the same results could have been produced by introducing a single cell into the fluid instead of several or many, as was done by Pasteur.

We have it therefore incontestably established that yeast possesses a property common only to plants—in short, that it is a plant—and we know, as a matter of practical ex-

perience, that its healthy cultivation is the principal occupation of the brewer, the distiller, and the producer of bakers' yeast.

But the successful and scientific cultivation of yeast must involve something more than the mere knowledge that it is a plant. The asparagus of our dinner tables and the weed of our garden path are both plants, yet sprinkling with common salt will secure the growth of the one and the death of the other; and if we investigate the reason for this strange dissimilarity of effect, it is capable of easy explanation when once we have made ourselves acquainted with the life history, the structure, and the composition of the two plants.

I cannot but think that in England there has been a tendency to neglect the study of yeast from this point of view, and if it be so, it it clearly because its practical bearings have not been made sufficiently apparent. I do not under-estimate the value of a knowledge of the chemistry involved in the phenomena of fermentation. It is not only essential, it is indispensable; but inasmuch as these phenomena are only among the ultimate phases of the life history of the plant, and are subject to modifications dependent upon the conditions of its culture, it follows that it is important to become acquainted with the natural history of yeast in all its bearings. If this be done, the chemistry of fermentation occupies but a subsidiary position, and relieves us from the necessity of being drawn at the commencement of our investigations into the vortex of dispute and doubt, by which an interpretation of the nature of fermentative processes has always been surrounded.

Yeast is then a plant. Yet how different from the popular conception of one! How vastly different, for instance, from the oak tree or the cabbage, with which it must evidently have something in common, since all are plants. To determine its position in the vegetable world, to ascertain what sort of plant it really is must obviously constitute our first endeavour, since it is only by thus locating its position that we can arrive at the broad characteristics of its life and development.

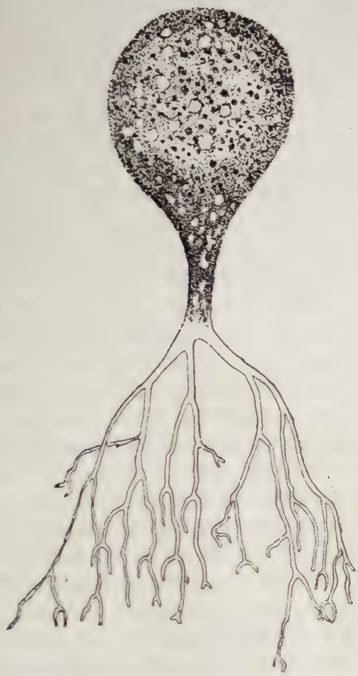
We are assisted in this by the masterly work of Sachs, who has made broad and comprehensive classifications of the utmost value. He shows us that a typical plant may be divided into two groups of organs—the root and the shoot. "The root is that part of a plant which becomes fixed on or in a substratum as an organ of attachment, and in the latter case serves for the absorption of nutritive matters contained in the substratum. The shoot, or to express it more generally, the system of shoots, of a plant is, on the other hand, originally that part which, becoming developed outside the substratum, produces and increases the substance of the plant, and brings forth in addition the reproductive organs which never appear on a root." The universal application of this division into root and shoot is well exemplified by the following illustrations of a tree, a seaweed, and a mould fungus.

FIG. I.

SEEDLING OF THE ALMOND (AMYGDALUS COMMUNIS), AFTER SACHS.

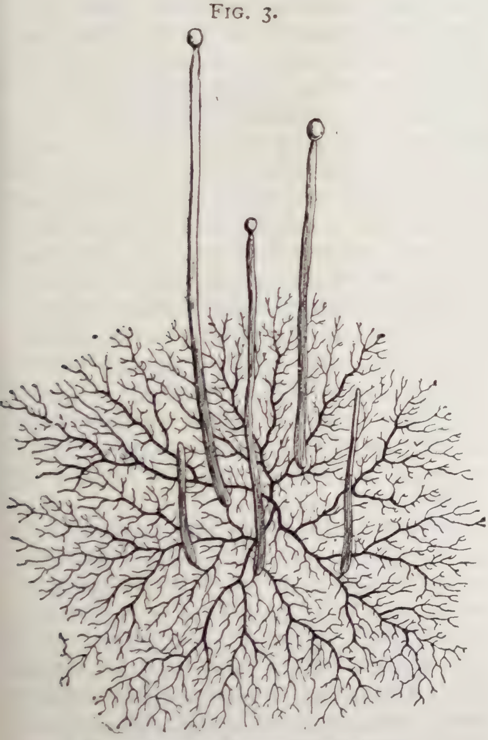
Sachs proves that in both cases the development will be dependent upon the functions which the root or shoot may be respectively called upon to perform.

FIG 2.



BOTRYDIUM GRANULATUM (MAGNIFIED THIRTY TIMES. ROSTAFINSKI).

FIG. 3.



PHYCOMYCES NITEUS (BRAFELD).

It is the necessity of searching for food which induces the development of the more highly organised functions in animals. If, for instance, a man were provided with the means of existence without the necessity of searching for it and striving to obtain it, there would be no occasion for the exercise of his intellectual powers in order to secure a supply of food. Attendant upon the disuse of these powers would be a suppression of brain activity, of the passions involved in food search, and of the muscular exertions by means of which the dictates of the brain are obeyed. The ultimate result of this would be a condensation of the whole organisation of man. The various functions having no stimulus, no source of irritation moving them to action, would cease to work, and in succeeding generations they would either disappear altogether or, losing their significance and specific differentiation, would become obscured or perhaps unrecognisable. Hence lack of stimulus induces laziness, and this is at once the prime cause of retrogression and the barrier to development.

So is it with plants. The root is an organ of attachment and the conveyor of nutriment—generally moisture and mineral matter—to the shoot. In many plants, and especially in trees, the attachment is a condition necessary to vigorous life, because the shoot system has to develop in a vertical direction, and to grow high above the ground in search of food. The greater the development of the shoot system, both laterally and vertically, the greater must be the strength of the system of attachment, and the more competent must be the means of conveyance of moisture and mineral matter. Hence it follows that the elaboration and development of the root is dependent upon that of the shoot. In other cases, the plant may obtain its nourishment nearer to hand, and the means of attachment may become useless; the root would then serve only as a means of conveying moisture and mineral matter to the shoot; or the plant might exist in water, and require the roots merely as organs of attachment. There are, indeed, many exaggerated instances of this kind to be found in nature, in which the root is merely indicated, and can scarcely be said to possess any definite function at all.

Is there, then, a suppression of the root and shoot in the case of yeast? If so, why? We have seen that the yeast plant is composed of single cells, each independent and constituting in itself a complete plant. The

typical foliage plant, as ordinarily known, is, on the other hand, an aggregation not of dependent but of interdependent cells, analogous in many respects to the single cell, but differing in the important particular that when separated and alone they are incapable of continuing their existence—of growing and reproducing their kind. These cells, however, are arranged in a defined manner with respect to one another, and are capable of performing specific processes connected with the life of the plant. To this end they secrete, or build up synthetically within themselves, certain ingredients endowed with the necessary chemical and physical attributes. Prominent among these is the substance known as chlorophyll. This body plays a remarkable *rôle* in the nutrition of the plant. It is found to be developed only in certain cells of the plant; it is embedded in protoplasm, and is incapable of exerting its well-known action when separated from these cells. In the presence of light, and under the influence of a certain amount of heat, it is capable of effecting the decomposition of carbonic acid gas. This becomes the chief source of the carbon required in the formation of plant tissue. Out of the carbon products thus decomposed, and in conjunction with water, the cells have the power of building up the compounds subsequently required for assimilation.

Chlorophyll is only found in the shoot system of plants, and in a particular part of it, to wit, the foliage. Hence those plants requiring an abundant supply of carbon compounds for assimilation, and dependent for that supply upon the power of chlorophyll to decompose carbonic acid gas, must be so constituted that they present to the light and in such a position that the presence of the necessary carbonic acid gas is secured, a large mass of cells containing chlorophyll. In such a case the fully developed root system and the shoot axis have, as Sachs points out, a meaning, for they serve not only to secure the retention of the foliage in the neighbourhood of the gas, but also to convey to the cells wherein the assimilable products are manufactured the moisture and mineral matters derived from the substratum. Hence in a plant containing chlorophyll we find the highest and most perfect structural developments, and there can be no doubt that they have all been called forth owing to the activity of chlorophyll in promoting the means of subsistence. Indeed, he further shows that we may go farther and assert that with the inability of plant cells to secrete chlorophyll, and with the acquisition of the power to obtain food under different conditions, there is a corresponding degeneration of structure both in root and shoot, until we ultimately arrive at a stage when the two become practically merged. In such a case we have only the reproductive organs to fall back upon as a means of recognition in their relation to the higher plants, and of these Sachs quaintly remarks that "They succumb less than the vegetative organs to the destructive action of laziness."

It is, then, abundantly evident that the question of food search is quite as important a factor in the determination of the structure of plants as it is in that of animals. Now there are many plants which do not contain chlorophyll, and which are consequently unable to decompose carbonic acid gas in order to obtain their carbon food. We should expect, therefore, that such plants would be devoid of highly developed root and shoot system, and wholly devoid of foliage. They either live as parasites, obtaining their food in a condition suitable for assimilation from their host plant, or they live on organic substances actually undergoing decomposition—*i.e.*, as saprophytes—and absorb their organic constituents before the latter are completely decomposed. Both these conditions of nutrition exist in the great plant division of the fungi, and since it is to this division that yeast belongs, we see at once how it is that we have to deal with a plant in which there is no special development either of shoot or of root. We see also that the intervention of light is not necessary to its nutrition, that it could not assimilate food from an atmosphere of carbonic acid gas, and, since yeast belongs to the saprophytic and not the parasitic class, that the nutrient medium to which I have referred must preferably be one containing organic matter in which a certain amount of decomposition has already been produced. We have therefore already gained certain broad fundamental conceptions respecting the necessary conditions of successful yeast culture.

The next step is obviously to ascertain what are the general characteristics and attributes of the family of fungi to which yeast belongs, and in order the better to do this, let us briefly glance at the position which they occupy with respect to other plants. The classification of plants, which botanists have been almost universally led to adopt with a view to their systematic study, is based

upon an examination of their powers of reproduction. It must, however, be borne in mind that the classification is artificial and not a natural one, and therefore mergings of one class into another are by no means uncommon. Subject to this caution, plant life may with advantage be broadly systematised as follows:—

PLANTS.

A.—PHANEROGAMIA (flowering plants containing anthers and ovules).

Two Subdivisions.

1. Gymnospermia (ovules not enclosed in ovary).
   - Cycadeæ (are all tropical trees).
   - Coniferæ (Juniper, Larch, Yew, Pine).
2. Angiosperma (ovules enclosed in ovary).
   - Monocotyledones (Maize, Oats, Wheat, Bamboo, Tulip).
   - Dicotyledones (Birch, Euphorbia, Foxglove, Tobacco, Primula, Pea).

B.—CRYPTOGAMIA (flowerless plants not containing anthers or ovules).

Four Subdivisions

1. Thallophytes (no leaves, no vascular tissue, cells only).
   - (*a*) Algæ (contain chlorophyll).
   - (*b*) Lichens (intermediate between *a* & *c*).
   - (*c*) Fungi (contain no chlorophyll). YEAST.*
2. Characeœ (submerged water plants with characteristic and peculiar system of reproduction).
3. Muscineœ (propagation by alternation of generations).
   - Hepaticœ (Liverworts).
   - Musci (Mosses).
4. Vascular Cryptogams.
   - Isoporous.
     - *Filices* (Ferns).
     - *Equisetaceæ* (Horsetails).
     - *Ophioglossaceæ* (Adder's Tongue).
   - Heterosporous.
     - *Rhizocarpæ* (Water Ferns).
     - *Lycopodiaceæ* (Selaginella).

An inspection of this Table allows us to locate the position of the fungi in the vegetable world. We see that they are flowerless plants, That they do not, like the pea and the bean, reproduce their kind by the sexual organs known as anthers and ovules. That they are cellular plants devoid of leaves, and that they are closely related to the seaweed and the lichens.

Indeed, it is this latter relationship which renders clear the position of fungi in the systematic scheme of natural descent, and leaves but little room for doubt that they, and therefore yeast, are philogenetically connected with the algæ or seaweeds. This statement, which can scarcely yet be said to be irrefutably established, is nevertheless based upon evidence of the strongest kind, and is of paramount importance in all considerations affecting the life, history, and nutrition of yeast. The lichens constitute an intermediate stage between fungi and algæ, and are indeed compounded of the two, recent researches having clearly shown that they are produced by certain fungi known as ascomycetes weaving themselves around algæ, usually of microscopic dimensions, and that the resulting product is a lichen. It will be shown that yeast, as at present classified, is also included among the ascomycetous fungi. Hence its relation to other plants bids

fair to be capable of rational and accurate explanation.

The absence of chlorophyll in all fungi results, as might be expected, in a simplification of their structure. Notwithstanding the great diversity of forms which are met with among them, the existence of some as bodies of considerable weight and apparently complex organisation, and of others endowed with functions capable of occasioning the most extraordinary and intricate phenomena, it will be found that this simplicity of typical structure is characteristic throughout. Nevertheless, thay have most important functions to perform in connection with the economy of life, and but for their presence, or of some class of bodies similarly endowed, the comparatively rapid combustion of dead plants and animals would not be possible. They break down complicated organic structure, and resolve it into simpler constituents, which are subsequently needed for purposes connected with food assimilation. They do this in virtue of a remarkable property which many of them possess of effecting the decomposition of a far greater amount of substance than they themselves can possibly require as food. This is more especially true of purely saprophytic fungi, which include by far the greater number of known species. Nägeli has shown it to be true of yeast, and has proved that the weight of yeast actually produced in a given quantity of wort falls far below the amount theoretically required to account for the amount of wort decomposed. A satisfactory explanation of this observation is still wanting.

The decomposition of organic matter effected by fungi may result in the manifestation of two classes of phenomena, fermentation and putrefaction, the former usually, but not exclusively, resulting from the life and multiplication of the various species of saccharomyces; the latter from those of schizomycetes or bacteria. The true classification of bacteria has been attended with great difficulty, more especially because some have been recognised in which the presence of chlorophyll is clearly evident. Excluding these, they are true fungi in the somewhat restricted sense in which Nägeli uses the term; they are thallophytes devoid of chlorophyll; the word thallus connoting the simpler forms of plants in which the more elaborate differentiations are no longer apparent. It suggests a fusion of root and shoot into one general mass so far as this involves the whole body of the plant, exclusive of that portion serving as an organ of reproduction.

Accepting this interpretation of the term, fungi may be regarded as consisting of the thallus and the reproductive organs; the latter formed of a bion, or growth, morphologically independent plus the mother cell which produced it. The organs of reproduction are distinguished as spores, gonidia, asci, &c., according to their structure and mode of development. The thallus is further subdivided into the mycelium and the sporophore—the former, the analogue of the root in the higher plants, never bears the organ of reproduction; the latter, the analogue of the shoot, bears the spores by means of which reproduction is effected. The mycelium may vary morphologically in a manner similar to the root system of higher plants, with the conditions of life and the peculiarities of nutritive adaptation of the fungus in question. Thus, if the fungus is parasitic it will generally develop mycelial filaments, termed haustoria, which serve to attach the root of the thallus to the host upon which it lives, and to draw nutriment therefrom. In some cases the mycelium may assume the appearance of a thick felt, which may be removed and handled as an apparently homogeneous mass, this form being familiar to all in the case of the moulds. In others there may be developed, upon filamentous branches of the mycelia, chambers for the storing of reserve nutriment. These store-houses, termed sclerotia, may undergo a specific development of their own, become detached from the mycelium, may be in a resting state for a considerable time, and ultimately give rise to sporophores, which bear spores at the expense of the reserve material above mentioned.

But in these and all other cases the mycelium is typified by the simplicity of its structure. It is invariably formed of hyphæ, which may become interwoven or cemented together by pressure, or in some cases by a species of parenchyma, but which are easily separable as independent hyphæ. These hyphæ are slender, thread-like, cylindrical cells, capable of extension by apical growth, and of subdivision by means of transverse septa, which latter are formed during the progress of their development. The walls of the cylinders are formed of cellulose, differing in some respects from the cellulose of chlorophyll plants, and enclose protoplasmic fluid. The sporophore—the branch or branches of the thallus bearing the spores—is similarly

formed of hyphæ, characterised by the same comparative simplicity of structure. They may become morphologically complicated, but in few cases is there great difficulty in satisfactorily referring them to the typical form. Familiar examples of compound sporophores are furnished by the well-known stalked umbrella forms of the edible mushrooms. The propagation of fungi is generally effected by the abjunction or complete separation of cells from the sporophores, which may then develop into bions capable of development. A single cell thus abjointed is termed a spore.

Spores are usually formed in one or two ways, by what is known as acrogenous abjunction, in which case they are formed at the summits of hyphal branches by transverse septation of the hyphæ; or they are produced by endogenous division. In this case the spores are produced inside mother cells, and are matured therein. They are then released and are capable of development. In many species the organ of reproduction is produced by the asexual formation of a propogative cell, which separates from the parent, and is capable of developing at once into a new bion. Such a cell is termed a gonidium, and the hypha bearing it a gonidiophore.

By far the greater number of species are, however, developed by means of asci; an ascus being a large cell, usually the swollen extremity of an hyphal branch of the organ of fructification. The spores are developed within the ascus, and are then known as ascospores. This term possesses an especial significance for us because it has been shown that yeast may be caused to develop ascospores, and advantage has been taken of the observation to base thereon a reliable and invaluable system of yeast analysis.

It will be shown that this method places it within the power of the brewer not only to determine the exact composition of the yeast with which he is working, but also to secure the propogation of a species of yeast the purity of which is unquestionable. It has, however, done more than this. It has determined the position of yeast among fungi with tolerable certainty, and has put an end to a series of arguments wherewith it was sought to prove that the various yeasts did not represent absolute fungal species, but merely stages in the cycle of development of a more highly organised group. Thus it was stated by those who were infected with what De Bary terms "the pleomorphic craze," that yeast when grown in saccharine fluids would exhibit the well known development of saccharomyces; if eaten by flies it would develop in them the germs of the insect fungi or entomopthora; that these might complete their development as insect fungi, but they might also develop into mucor or into achyla (*saprolegnieæ*) if the flies fell into water. Finally, it was asserted that mucor placed in saccharine fluids would result in its transference into saccharomyces, and thus the pleomorphic cycle was completed. These statements, which were based upon inaccurate experiments, resulted in the enunciation of an ingenious but highly mischievous theory of fermentation, of which Fremy was the leading and certainly the most logical exponent. The complete study of the ascospore formation of yeast, as carried out by Reess and Hansen, has absolutely dissipated these erroneous views, has placed the question of yeast culture upon an entirely new basis, and has moreover rendered possible, and indeed probable, the realisation of some of the most highly-cherished ideas of the practical brewer.

It would be impossible, within the limits of these lectures, to do more than glance at the intricate questions connected with general fungology. For more detailed study the reader is referred to the works of De Bary and Berkeley. I need scarcely apologise for stating that I have drawn most of my information from the pages of the former master, because not to have done so would have been to risk inaccuracy, and to have ignored the greatest authority upon the subject. The appended classification (p. 1050) is compiled from his book, and may serve to show the relationship of yeast to other familiar fungal forms, in so far as they are at present regarded by the highest authorities.

Now we have seen how the development of root and shoot is subject to modification, until ultimately a merging into one thallus is effected. In the same way it is to be expected that mycelium and sporophore should become merged, or that we should meet with some fungi in which mycelia are not developed. Again, the typical hyphal form with transverse septation may be departed from. That such forms are referable to the characteristic hyphal one can scarcely be doubted, but it may often require long studious investigations to discover the necessary proof. Among such modifications may be classed the so-called sprouting fungi, of which yeast is a type, and which are detailed in page 1052.

FUNGI.

Thallophytes which have no Chlorophyll.

Groups:—

1. SERIES OF THE ASCOMYCETES.

Phycomycetes

So called because of close approximation to the algæ.

1. Peronosporeæ:—Some live on the bodies of dead animals and plants; the greater number as parasites in the tissues of phanerogams—fertilisation by male and female organs.
   Ancylisteæ:—Parasites are fresh water algæ; closely related to peronosporeæ.
   Monoblepharis: — Incompletely studied; closely related to peronosporeæ.
2. Saprologenieæ:—Closely resemble peronosporeæ; live on dead organic bodies in water, mostly of large growth; male sexual organs wanting, or do not perform fertilising functions; spores in motile state when young issue from sporangium.
3. Mucorini:—Plants of the dry land; mostly grow on dead organic bodies, especially animal excrement; some parasitic on other mucorini, closely connected with peronosporeæ and saprologenieæ, but differ in forming zygospores and onidia. Subdivisions:—
   (*a*) Mucoreæ:—Spores found endogenously in terminal sporangia.
   (*b*) Chætocladieæ:—Spores abjointed acrogenously one by one.
   (*c*) Piptocephalideæ:—Spores formed acrogenously and serially by cross septations.
4. Entomopthoreæ:—Penetrate the cavities of bodies of living insects and there develop; form gonidiophores on hyphal branches; make their way through the body of the insect after its death, and complete their development on its outer surface.
5. Ascomycetes:—Composed of branched hyphæ; always septate; all form spores in asci; the asci are sporocarps or parts of them, and often collected together into hymenia.
   (*a*) Ascomycetes bearing apothecium.
   (*b*) Ascomycetes bearing perithecium.
   (*c*) Cleistocarpus Ascomycetes:—Spores released by rupturing cell wall.
6. Uredineæ:—Closely allied to ascomycetes; all parasites on living phanerogams and ferns; many complete their development on one host; others obliged to migrate from one host to another in order to arrive at certain stages of their development.

2. DIVERGENT ASCOMYCETES OF DOUBTFUL POSITION.

Considered in connection with phycomycetes............

7. Chytridieæ:—Microscopic; mostly live under water; swarm spores formed in sporangial cells. Subdivisions:—1. Rhizidieæ.
   2. Cladochytrieæ.
   3. Olpideæ.
   4. Synchitrieæ.

Considered in connection with phycomycetes	8. Protomyces and Ustilagineæ :— *Protomyces*—parasites in intercellular spaces of umbelliferous plants. *Ustilagineæ*—endophytic parasites in phanerogamous plants; phylogenetically a more highly developed group proceeding from the chytridieæ.
Considered in connection with 5, 10, and 6..............	9. Doubtful Ascomycetes :— *Laboulbenieæ*—grow on outer surface of beetles, have no mycelium. *Exoascus*—parasitic on the surface of parts of living plants. *Saccharomyces*—YEAST.*
	10. Basidiomycetes :— *Basidium*—mother cell from which spores are acrogenously abjointed. Basidia common to all members of the group. Subdivisions— *Hymenomycetes* (containing edible mushroom) closely connected with uredineæ. *Gasteromycetes*—
3. MYCETOZOA.	Resemblance in life and nutrition, and in structure and biological character, between their organs of reproduction and those of fungi. Subdivisions :— *Myxomycetes* (or slime fungi). *Acrasieæ*.
4. DOUBTFUL MYCETOZOA.	
5. SCHIZOMYCETES, OR FISSION-FUNGI.	Bacteria, at present including some chlorophyll forms. Subdivisions :— *Endosporous*—spirillum, bacilli (rods, vibrios, &c). *Arthosporous*—spores capable of giving rise to new combinations.

CLASSIFICATION OF FUNGI ACCORDING TO NUTRITIVE ADAPTATION.

	Classified according to nutritive adaption.
1. Pure saprophytes	Comprising by far the greater number of the known fungi.
2. Facultative parasites........	May be able to obtain full development both as saprophyte and parasite. (Fungi which attack the bodies of living animals). *Eg. aspergillus.*
3. Obligate parasites..........	Subdivisions :— (*a*) Strictly obligate parasites. Living only as parasites. *Saprolegnieæ* (salmon disease). (*b*) Facultative parasites. Development possible as saprophyte. (Certain saprophytic moulds, causing orchard fruit to rot).

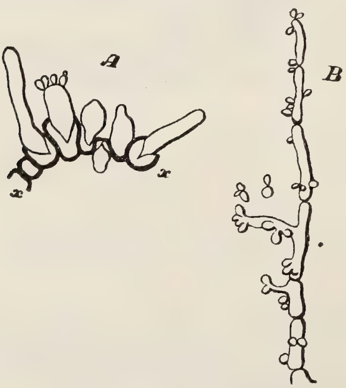
SPROUTING FUNGI.

Ascogenous.	Non-Ascogenous.
Saccharomyces Cerevisiæ.	Saccharomyces Apiculatus.
Do. Ellipsoideus.	Do. Glutinis.
Do. Pastorianus.	Do. Albicans (Thrush).
	Do. Exiguus.
	Do. Conglomeratus (?).
	Monilia candida.
	Chalara Mycoderma.*
	Torula.
	Exoascus.
	Dothidea Ribesia.
	Nectria (some species).
	Dematium Pullulans.
	Mucorini (some species).
	Ustilagineæ (some species).
	Tremellineæ (some species).
	Fumago.
	Exobasidium.
	S. Mycoderma.

* Can form *hyphæ* under favourable conditions.

The importance of subdividing them into those which form ascospores and those which do not, will be made apparent as we proceed. It may suffice to remark here that *Dematium pullulans* and *Monilia candida* (Figs. 4 and 5) have often been mistaken for yeast, with which they have many morphological points in common. Their identification is rendered comparatively easy by reference to the method of ascospore analysis.

Fig. 4.



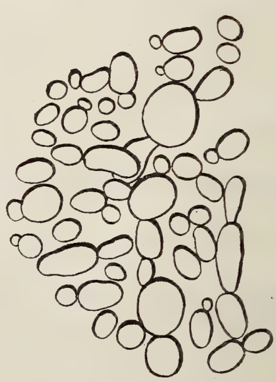
Dematium Pullulans.

A, x x, portion of a row of cells with brown membranes forming tubes and occasionally sprouts in a saccharine solution (magnified 390 times). *B*, portion of a filament vegetating in a saccharine solution, and covered with sprout cells (magnified nearly 200 times).—De Bary.

It was formerly imagined that alcoholic fermentation could only be produced by sprouting fungi; but this has been disproved by the researches of Pasteur and others. Recent investigation, indeed, favours the view that many other forms, including some Bacteria, will be found which, under certain conditions, may be made to develop this property. The Table on page 1053 includes all the fungi known to be capable of inciting alcholic fermentation.

Of these it should be remarked that some have only given evidence of the power to a limited extent. For instance, *S. albicans*—the fungus which is said to produce *apthæ*, or

Fig. 5.



Monilia Candida (Hansen).

the disease known as "thrush"—will, if transferred to saccharine solutions, incite alcoholic fermentation, but of a very mild character compared with that of *S. cerevisiæ*. It would

FUNGI.

Inciters of Alcoholic Fermentation.	Non-Inciters of Alcoholic Fermentation.
Saccharomyces Cerevisiæ.	Saccharomyces Glutinis.
Do. Ellipsoideus.	Do. Mycoderma (generally).
Do. Pastorianus.	Exoascus Pruni.
Do. Apiculatus.	Dematium Pullulans.
Do. Exiguus.	Fumago.
Do. Albicans.	
Do. Mycoderma (rarely).	
Do. Conglomeratus (?).	
Mucor Racemous (*a*) Hyphal form.	
(*b*) Sprouting form.	
Do. Circinelloides.	
Do. Spinosus } small.	
Do. Stolonifer } small.	
Exoascus Alnitorquus (Sadebeck).	
Torula.	
Eurotium Aspergillus Glaucus.	
(Hyphal form—Pasteur).	

be rash to assert that some method may not hereafter be found of causing fungi, other than those at present commercially employed, to develop alcoholic fermentation with such vigour as to lead to their use in practice; but in the existing state of knowledge these functions are exclusively reserved for the sacharomyces.

Having now become familiar with some of the more general considerations respecting yeast, we are in a better position to approach and appreciate its more detailed study. I propose that we should devote ourselves to this task in the following and succeeding lectures, and that we should dwell more especially upon those observations of which foreigners have already taken practical advantage with signal success.

Miscellaneous.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION, HELD AT BATH, SEPTEMBER, 1888.

By William Henry Preece,
F.R.S., M.Inst.C.E., &c., President of the Section.

"Canst thou send lightnings, that they may go, and say unto thee, here we are?" were pregnant words addressed to Job, unknown centuries ago. They express the first recorded idea in history of the potentiality of electricity to minister to the wants of mankind. From Job to Franklin is a long swing in the pendulum of time. It is not until that American philosopher brought down atmospheric electricity by his kite-string in 1747, and showed that we could lead it where we willed, that we were able to answer the question addressed to the ancient patriarch. Nearly another century elapsed before this mysterious power of Nature was fairly conquered. It has been during this generation, and during the life of the British Association, that electricity has been usefully employed; and it is because I have taken a subordinate position in inaugurating nearly all of its practical applications, that I venture to make the developments of them the text of my address to this section.

People are singularly callous in matters affecting their own personal safety; they will not believe in mysteries, and they ridicule or condemn that which they do not understand. The Church itself set its face against Franklin's "impious" theories, and he was laughed to scorn by Europe's scientific sons; and even now, though commissions composed of the ablest men of the land have sat and reported on Franklin's work in England, France, and nearly every civilised nation, the public generally remains not only ignorant of the use of lightning conductors, but absolutely indifferent to their erection, and, if erected, certainly careless of their proper maintenance. I found in a church, not very far from here, the conductor leaded into a tombstone, and in a neighbouring cathedral the conductor only a few inches in the ground, so that I could draw it out with my hand. Although I called the attention of the proper authorities to the absolute danger of the state of affairs, they remained in the same condition for years.

Wren's beautiful steeple in Fleet-street, St. Bride's, was well-nigh destroyed by lightning in 1764. A lightning rod was fixed, but so imperfectly that it was again struck. In July last (1887), it was damaged because the conductor had been neglected, and had lost its efficiency.

As long as points remain points, as long as conductors remain conductors, as long as the rods make proper connection with the earth, lightning protectors will protect; but if points are allowed to be fused, or to corrode away; as long as bad joints or faulty connections are allowed to remain; as long as bad earths or no earths exist, so long will protectors cease to protect; and they will become absolute sources of danger. Lightning conductors, if properly erected, duly maintained, and periodically inspected, are an absolute source of safety; but if erected by the village blacksmith, maintained by the economical churchwarden, and never inspected at all, a loud report will some day be heard, and the beautiful steeple will convert the churchyard into a new geological formation.

We have not yet acquired that mental confidence in the accuracy of the laws that guide our procedure in protecting buildings from the effects of atmospheric electrical discharges which characterises most of the practical applications of electricity. Some of our cherished principles have only very recently received a rough shaking from the lips of Professor Oliver Lodge, F.R.S., who, however, has supported his brilliant experiments by rather fanciful speculations, and whose revolutionary conclusions are scarcely the logical deduction from his novel premises. The whole subject is going to be thoroughly discussed at this meeting.

We are now obtaining much valuable information about the nature of lightning from photography. We learn that it does not, as a rule, take that zigzag course conventionally used to represent a flash on canvas. Its course is much more erratic and sinuous, its construction more complicated, and pictures have been obtained of *dark* flashes whose *raison d'être* has not yet been satisfactorily accounted for. The network of telegraph wires all over the country is peculiarly subject to the effects of atmospheric electricity, but we have completely mastered the vagaries of lightning discharges in our apparatus and cables. Accidents are now very few and far between.

The art of transmitting intelligence to a distance beyond the reach of the ear and the eye, by the instantaneous effects of electricity, had been the dream of the philosopher for nearly a century, when in 1837 it was rendered a practical success by the commercial and far-sighted energy of Fothergill Cooke, and the scientific knowledge and inventive genius of Wheatstone. The metallic arc of Galvani (1790) and the developments of Volta (1796) had been so far improved, that currents could be generated of any strength; the law of Ohm (1828) had shown how they could be transmitted to any distances; the deflection of the magnetic needle by Oersted in 1819, and the formation of an electro-magnet by Ampère and Sturgeon, and the attraction of its armature, had indicated how these currents could be rendered visible as well as audible.

Cooke and Wheatstone, in 1837, utilised the deflection of the needle to the right and the left to form an alphabet. Morse used the attraction of the armature of an electro-magnet to raise a metal style, to impress or emboss moving paper with visible dots and dashes. Steinheil imprinted dots in ink on the different sides of a line on paper, and also struck two bells of different sound to affect the ear. Bréguet reproduced in miniature the actual movements of the semaphore then so much in use in France: while others rendered practical the favourite idea of moving an indicator around a dial, on which the alphabet and numerals were printed, and causing it to dwell against the symbol to be read—the A B C instrument of Wheatstone in England, and of Siemens in Germany. Wheatstone conceived the notion of printing the actual letters of the alphabet in bold Roman type on paper—a plan which was made a perfect success by Hughes in 1854.

At the present moment the needle system of Cooke and Wheatstone, as well as the A B C dial telegraph, are very largely used in England on our railways and in our smaller post-offices. The Morse recorder and the Hughes type-printer are universally used on the continent; while in America the dot and dash alphabet of Morse is impressed on the consciousness through the ear by the sound of the moving armature striking against the stops that limit its motion. In our larger and busier offices the Morse sounder and the bell system, as perfected by Bright, are very largely used, while the press of this country is supplied with news which is recorded on paper by ink dots and dashes at a speed that is marvellous.

Sir William Thomson's mirror—the most delicate form of the needle system—where the vibratory motions of an imponderable ray of light convey words to the reader, and his recorder, where the wavy motion of a line of ink spirted on paper by the frictionless repulsion of electricity, performs the same function, are exclusively employed on our long submarine cables.

Bakewell, in 1848, showed how it was possible to reproduce *fac similes* of handwriting and of drawing at a distance; and in 1879, E. A. Cowper reproduced one's own handwriting, the moving pen at one station so controlling the currents flowing on the line wire that they caused a similar pen to make similar motions at the other distant station. Neither of these plans, the former beautifully developed by Caselli and d'Arlincourt; and the latter, improved by Robertson and Elisha Gray, have yet reached the practical stage.

The perfection of telegraphy has been attained by that chief marvel of this electrical age—the speaking telephone of Graham Bell. The reproduction of the human voice at a distance, restricted only by

geographical limits, seems to have reached the confines of human ingenuity; and though wild enthusiasts have dreamt of reproducing objects abroad visible to the naked eye at home, no one at the present moment can say that such a thing is possible, while, in face of the wonders that have been done, no one dare say that it is impossible.

The commercial business of telegraphy, when our thoughts and wishes, orders and wants, could be transmitted for money, was inaugurated in this country by the establishment of the Electric Telegraph Company in 1846, and until 1870 it remained in the hands of private enterprise, when it was purchased by the Government, and placed under the sole control of the Postmaster-General. It has been the fashion to decry the terms of purchase of the various undertakings then at work by those who have not understood the question, and by those who, being politically opposed to the Government in power at the time, saw all their acts not only through a glass darkly but through a reversing lens. A business producing £550,000 per annum was bought at 20 years' purchase, and that business has now increased to £2,000,000 per annum; 6,000,000 messages per annum have increased to 52,000,000.

Every post-office has been made a telegraph office, every village of any size has its wire; messages which used to cost 12s. 6d. are now sent for 6d. A tariff which was vexatious from its unfair variation is now uniform over the United Kingdom, and no one can justly complain of error or delay in the transmission of their messages. Silly complaints are sometimes inserted in the press of errors which the most elementary knowledge of the Morse alphabet would detect, and little credit is given to the fact that the most perfect telegraph is subject to strange disturbances from terrestrial and atmospheric causes, which admit sources of error beyond the control of the telegraphist. A flash of lightning in America may cause an extra dot in Europe, and *man* may become *war*. An earthquake in Japan may send a dash through France, and *life* would become *wife*. A wild goose flying against a telegraph wire might drive it into momentary contact with another wire, and *sight* might become *night*. Everyone should know the Morse alphabet, and people should learn how to write. Nine-tenths of the errors made are due to the execrable caligraphy of the present day. As a matter of fact, in ninety-nine cases out of a hundred, the telegraphist delivers to the editor of a newspaper "copy" far more accurate than the first proof of his own leader submitted by the printer. The quantity of news transmitted is enormous, an average of 1,538,270 words are delivered per day. The recent convention in Chicago, when the Republican party of the United States nominated their candidate for the presidentship, created so much business, that every American paper has chronicled this big thing as unique. Five-hundred thousand words were sent on one night; but we in England, when Mr. Gladstone introduced his celebrated Home Rule Bill, on April 8, 1886, sent from the Central Telegraph-office in London 1,500,000 words.

The growth of business has led to vast improvement in the carrying capacity of the wires. Cooke and Wheatstone required five wires for their first needle instrument to work at the rate of four words per minute. One wire can now convey six messages at ten times the speed. The first Morse apparatus could work at about 5 words a minute; we now transmit news at the rate of 600 words a minute. In 1875, it was thought wonderful to transmit messages to Ireland at 80 words a minute. When I was recently in Belfast, I timed messages coming at the rate of 461 words a minute. Duplex working—that is, two messages travelling on the same wire at the same time, in opposite directions, the invention of Gintl, of Vienna—is now the normal mode of working; Edison's quadruplex is common; and the Delany system of multiplex working is gradually being introduced, by which six messages are indiscriminately sent in either direction. The telegraphic system of England has been brought to the highest pitch of perfection. We have neither neglected the invention of other countries, nor have we been chary of exercising inventive skill ourselves, and we have received onr full meed of that reward which is always freely bestowed on a British Government official—neglect and abuse. All parts of the civilised world are now united by submarine cables. The *Times* every morning has despatches from every quarter of the globe, giving the news of the previous day; 110,000 miles of cable have been laid by British ships, and nearly £40,000,000 of British capital has been expended by private enterprise in completing this grand undertaking. A fleet of 37 ships is maintained in various oceans to lay new cables and to repair breaks and faults as they occur, faults that arise, among other causes, from chafing on coral reefs, ships' anchors, the onslaught of insects, and earthquakes. The two cables connecting Australia and Java were recently simultaneously broken by an earthquake.

The politician, unmindful of the works of the engineer, is apt to apply to the credit of his own proceedings the growing prosperity of the world. The engineer, however, feels that steam and electricity in his hands have done more to economise labour, to cheapen life, to increase wealth, to promote international friendship, to alleviate suffering, to ward off war, to encourage peace, than all the legislation and all the verbosity of the politician.

The railways of this country are entirely dependent for the conduct of their traffic on the telegraph, and the security of their passengers is mainly due to the working of the block system. A railway, say between London and Bath, is broken up into certain short sections, and only one train is allowed on one section at one time. The presence, motion, and departure of trains is announced and controlled by electric signals, and the out-door signals are governed by

these electric signals. There are few more interesting places to visit than a well-equipped signal-box on one of our main railways. The signalman is able to survey the lines all around and about him by aid of his electric signals; he can talk by telegraph or y telephone to his neighbours and his station-master; he learns of the motion of the trains he is marshalling by the different sounds of electric bells; he controls his out-door signals by the deflection of needles, or the movement of miniature semaphores; he learns the true working of his distant signals by their electrical repetition; machinery governs and locks every motion he makes, so that he cannot make a mistake. The safety of railway travelling is indicated by the fact that while in the five years ending 1878 thirty-five people were killed annually from causes beyond their own control, in the five years ending 1887 the average has been reduced to sixteen. One person is killed in 35,000,000 journeys made by train. Wherever we are dependent on human agency, we are subject to human error, and a serious accident very recently at Hampton Wick has shown how the most perfect machinery may be rendered valueless to protect life when perversity, thoughtlessness, or criminality enter as factors into the case.

At the meeting of the Association in Plymouth, in 1877, I was able, for the first time in this country, to show the telephone at work. Since then its use has advanced with giant strides. There are probably a million instruments at work now throughout the civilised world. Its development has been regularly chronicled at our meetings. As far as the receiving part of the apparatus is concerned, it remains precisely the same as that which I brought over from America in 1877; but the transmitter, ever since the discovery of the microphone by Hughes, in 1878, has been entirely remodelled. Edison's carbon transmitter was a great step in advance; but the modern transmitters of Moseley, Berliner, D'Arsonval, De Jongh, leave little to be desired. The disturbances due to induction have been entirely eliminated, and the laws regulating the distance to which speech is possible are so well known, that the specification of the circuit required to connect the Land's End with John O'Groat's by telephone is a simple question of calculation. A circuit has been erected between Paris and Marseilles, 600 miles apart, with two copper wires of 6½ gauge, weighing 540 lbs. per mile, and conversation is easily maintained between those important cities at the cost of three francs for three minutes. One scarcely knows which fact is the more astounding, the distance at which the human voice can be reproduced, or the ridiculously simple apparatus that performs the reproduction. But more marvellous than either is the extreme sensitiveness of the instrument itself, for the energy contained in one heat unit (gramme-water-degree) would, according to Pellat, maintain a continuous sound for 10,000 years.

The influence which electric currents exert on neighbouring wires extends to enormous distances, and communication between trains, and ships in motion, between armies inside and outside besieged cities, between islands and the mainland, has become possible without the aid of wires at all, by the induction which is exerted through space itself. On the Lehigh Valley Railway, in the United States, such a system of telegraphing without wires is in actual daily use.

The conduct of telephonic business in England is still in the hands of those who hold the patents, and who maintain a most rigid monopoly. These patents have only a short period to run, and when they expire we may expect to find that England will not occupy the very retired position she holds now as a telephone country. Stockholm has more subscribers than London; there are 15,000 subscribers in and about new York, while the number in London is only 4,851.

Electric lighting has become popular, not alone from the beauty of the light itself, but from its great hygienic qualities in maintaining the purity and coolness of the air we breathe. The electric light need not be more brilliant than gas, but it must be more healthy. It need not be cooler than a wax candle, but it must be brighter, steadier, and more pleasant to the eye. In fact, it can be rendered the most perfect artificial illuminant at our disposal, for it can illumine a room without being seen directly by the eye; it can be made absolutely steady and uniform without irritating the retina; it does not poison the air by carbonic acid and carbonic oxide, or dirty the decorations by depositing unconsumed carbon; it does not destroy books or articles of *vertu* and art by forming water which absorbs sulphur acids; and it does not unnecessarily heat the room.

In our Central Savings Bank in London it has been found, after two years' experience of electric lighting, that the average amount of absences from illness has been diminished by about two days a year for each person on the staff. This is equivalent to a gain to the service of the time of about eight clerks in that department alone. Taking the cost at the "overtime" rate only, this would mean a saving in salaries of about £640 a year. The cost of the installation of the electric light was £3,349, and the annual cost of working £700 per annum, say a total annual cost of £1,034. The cost of the gas consumed for lighting purposes was about £700 a year, so that on the whole there was a direct saving of something like £266 a year to the Government, besides the material advantage of the better work of the staff resulting from the improved atmospheric conditions under which their work is done.

The production of light by any means implies the consumption of energy, and this can be measured in *watts*, or at the rate at which this energy is consumed. A watt is $\frac{1}{746}$ part of a *horse power*. It is a very convenient and sensible unit of power, and will in time replace the meaningless horse-power.

				Watts.
One candle light maintained by	tallow............	absorbs	124
,,	,,	wax................	,,	94
,,	,,	sperm..............	,,	86
,,	,,	mineral oils......	,,	80
,,	,,	vegetable oil ...	,,	57
,,	,,	coal gas	,,	68
,,	,,	cannel gas	,,	48
,,	,,	electricity (glow)	,,	3
,,	,,	electricity (arc)	,,	55

The relative heat generation of these illuminants may be estimated from these figures.

Though the electric light was discovered by Davy in 1810, it was not until 1844 that it was introduced into our scientific laboratories by Foucault; it was not until 1878 that Jablochkoff and Brush showed how to light up our streets effectually and practically; it was not until 1881 that Edison and Swan showed how our homes could be illuminated softly and perfectly. Unpreparedness for such a revolution produced a perfect panic among gas proprietors; inexperience in the use of powerful electric currents resulted in frequent failure and danger; speculation in financial bubbles transferred much gold from the pockets of the weak to the coffers of the unscrupulous; hasty legislation in 1882 restricted the operations of the cautious and wise; and the prejudice arising from all these causes has, perhaps fortunately, delayed the general introduction of electricity; but now legislation has been improved, experience has been gained, confidence is being restored, and in this beautiful town of Bath fifty streets are about to be lighted, and we see everywhere around and about us in our English homes the pure glow lamp replacing filthy gas and stinking oil. The economical distribution of the electric current over large areas is annually receiving a fresh impetus. The expensive systems defined in the Act of Parliament of 1882 have entirely disappeared. Hopkinson in England and Edison in America showed how a third wire reduced the weight of copper needed by 66 per cent. Gaulard and Gibbs in 1882 showed how the conversion of alternate currents of high electromotive force to currents of low electromotive force by simple induction coils would enable a mere telegraph wire to convey sufficient electricity to light a distant neighbourhood economically and efficiently. Lane Fox, in 1879, showed how the same thing could be done by secondary batteries; and Planté, Faure, Sellon, and Parker have done much to prove how batteries can be made to solve the problem of storage; while King and Edmunds have shown how the distribution by secondary batteries can be done as economically as by secondary generators. The Grosvenor Gallery Co. in London have proved the practicability of the secondary generator principle by nightly supplying 24,000 glow lamps scattered over a very wide area of London. The glow lamp of Edison, which in 1881 required 5 watts per candle, has been so far improved that it now consumes but $2\frac{1}{4}$ watts per candle. The dynamo, which in the same year weighed 50,000 lbs., absorbed 150 horse-power, and cost £4,000 for 1,000 lamps, now weighs 14,000 lbs., absorbs 110 horse-power, and costs £500 for the same production of external energy; in other words, its commercial output has been increased nearly six times, while its prime cost has been diminished eight times.

The steam-engine has received equal attention. The economy of the electric light when steam is used depends almost entirely on the consumption of coal. With slow-speed low-pressure engines one kilowatt (1,000 watts, $1\frac{1}{3}$ horse-power) may consume 12 lbs. of coal per hour; in high-speed, high-pressure, triple-expansion engines it need not consume more than 1 lb. of coal per hour. Willans and Robinson have actually delivered from a dynamo one kilowatt by the consumption of 2 lbs. of coal per hour, or by the condensation of 20 lbs. of steam.

There is a great tendency to use small economical direct-acting engines in place of large expensive engines, which waste power in countershafting and belts. Between the energy developed in the furnace in the form of heat, and that distributed in our rooms in the form of light, there have been too many points of waste in the intermediate operations. These have now been eliminated or reduced. Electricity can now be produced by steam at 3d. per kilowatt per hour. The kilowatt hour is the Board of Trade unit, as defined by the Act of 1882, for which the consumer of electric energy has to pay. Its production by gas-engines costs 6d. per kilowatt-hour, while by primary batteries it costs 3s. per kilowatt-hour. The Grosvenor Gallery Company supply currents at $7\frac{1}{4}$d. per kilowatt-hour; a 20 candle-power lamp, consuming three watts per candle, and burning 1,200 hours per annum, expends 82,000 watt-hours or 82 kilowatt-hours, and it costs, at $7\frac{1}{4}$d. per unit, 50s. per annum. If the electricity be produced on the premises, as is the case in the Post-office, in the House of Commons, and in many large places, it would cost 20s. 6d. per annum. I have found from a general average, under the same circumstances and for the same light, in the General Post-office in London, that an electric glow lamp costs 22s. and a gas lamp 18s. per annum. The actual cost of the production of one candle light per annum of 1,000 hours is as follows:—

	s.	d.
Sperm candles	8	6
Gas (London)............	1	3
Oil (petroleum)	0	8
Electricity, glow..........	0	9
,, arc	0	$1\frac{1}{2}$

The greatest development of the electric light has taken place on board ship. Our Admiralty have been foremost in this work. All our warships are gradually receiving their equipment. Our ocean-going passenger ships are also now so illumined, and perhaps it is here that the comfort, security, and true blessedness of the electric light is experienced.

Railway trains are also being rapidly fitted up,

The express trains to Brighton have for a long time been so lighted, and now several northern railways, notably the Midland, are following suit. Our rocky coasts and prominent landfalls are also having their lighthouses fitted with brilliant arc lamps, the last being St. Katherine's Point on the Isle of Wight, where 60,000 candles throw their bright beams over the English Channel, causing many an anxious mariner to proceed on his way rejoicing.

(*To be continued.*)

*THE GRAPHOPHONE.**

In 1681, Dr. Hooke exhibited some experiments before the Royal Society, showing how musical notes and other sounds could be produced by means of toothed wheels rapidly rotated. In 1854, Charles Bourseuil proposed to use two diaphragms, connected by an electric wire, and, by speaking into one of them reproduce the spoken sounds at any distance in the other. This idea was actually carried out by Philipp Reis five years later. The phonautograph was patented by Leon Scott, in 1857; and Faber constructed a complicated speaking machine, which pronounced a few words and sentences most unsatisfactorily. But in 1876 appeared the Bell telephone, the first really perfect instrument for the transmission of speech. In April, 1887, M. Charles Cros deposited a paper at the Academy of Sciences in Paris on "A Process of Recording and Reproducing Audible Phenomena," in which he proposed to obtain tracings of sound-waves by means of a vibrating membrane. Then, by going over these tracings with a stylus attached to another membrane, the sounds would be reproduced. Consequently, to M. Cros belongs the credit of having suggested a means of mechanically recording and reproducing spoken sounds. Later in the year, Mr. Thomas Alva Edison realised his idea in his phonograph. Mr. Edmunds described it in a report to the *Times* on the 17th February, 1878. Shortly afterwards, Mr. W. H. Preece exhibited at the Royal Institution the first phonograph made in this country under Mr. Edmunds's instructions. The instrument created a great sensation, and glowing anticipations were entertained of its future application, but it was found that its articulation was far too imperfect, and its general performance too crude, to admit of its being used for any practical purpose; and Mr. Edison himself gave it up, applying himself to other work, even allowing his two English patents to lapse. But in 1881, Professor Graham Bell, inventor of the telephone, with Dr. Chichester A. Bell, and Mr. Charles Sumner Tainter, formed the Volta Laboratory Association in Washington, for the purpose of investigating the art of transmitting, recording, and reproducing sound. They conducted many elaborate experiments, and, among other things, sought for and discovered the cause of the failure of the Edison phonograph. They found that tinfoil, as used in that instrument, was far too pliable for the purpose, as it always had a tendency to pucker and destroy the symmetry of the sound-waves. They perceived that no good result could be obtained by merely indenting a pliable material; it was necessary to engrave a record in a solid resisting body; and this discovery enabled them to produce a really practical instrument, which they termed the "Graphophone." Instead of tinfoil, Mr. Tainter employed wax, ploughing out, by means of a vibratory stylus, a narrow undulating groove, which constituted a sound record. When this groove was retraced by another stylus and diaphragm, the original sounds were reproduced with a fidelity undreamed of by those only acquainted with the phonograph. In 1885, the Volta Laboratory Association was dissolved after performing most important work, and taking out a series of valuable patents.

Mr. Tainter has brought the experience of years to the perfection of the graphophone. The kernel of the invention is the "recording cylinder," 6 inches long, by 1¼ inches broad, formed of cardboard coated with wax. This is placed in a small lathe and rotated by a treadle in contact with the "recorder," which consists of a metal frame supporting a thin mica diaphragm, in the centre of which is a steel point that cuts a narrow groove on the surface of the cylinder, according to the quality and intensity of the sound spoken against it. The recorder is then removed, and replaced by the "reproducer," a light feather of steel that travels along the grooves made on the cylinder, and transmits their undulations to a small mica diaphragm, which, in its turn, communicates its vibrations, as sound-waves, to the ears of the auditor by means of two india-rubber tubes, for Mr. Tainter thought it best to reduce the size of the record, and concentrate the sound in this way, on account of the greater distinctness that was thus secured. The manipulation of the graphophone is simplicity itself. It requires no adjustment, no electric motor, no galvanic battery. The foot supplies the motive power, and the machine regulates its own speed by means of an ingenious but simple governor. Journalists and reporters may dictate their articles and reports, leaving others to transcribe them. The principal of a firm can speak his day's correspondence into the machine, which will repeat it sentence by sentence to be written down in proper form by pen or type-writer. Or purely verbal communication can be carried on through the post by means of the record cylinders, which are extremely light, although capacious enough to hold 1,000 words a piece. All these applications are now in active operation in America, where the graphophone has achieved a great success.

* Abstract of paper read by Mr. Hy. Edmunds, in Section G of the British Association, 6th Sept., 1888.

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CANTOR LECTURES.

YEAST; ITS MORPHOLOGY AND CULTURE.

By A. Gordon Salamon, A.R.S.M., F.I.C., F.C.S.

Lecture II.—Delivered February 6, 1888.

We have seen that the property of inciting alcoholic fermentation, in saccharine fluids, is by no means confined to what is popularly comprehended under the name of yeast. It is shared—in a minor degree, it is true—by many fungi differing essentially from yeast in morphological structure and manner of reproduction; and it is anticipated that subsequent investigation will lead to the discovery that the power of manifesting the phenomenon is far more widely distributed than is even at present thought to be the case. It is therefore obvious that any definition seeking to limit this power to yeast would be seriously inaccurate and misleading. Yet such was the opinion almost universally held until within about the last sixteen years, when Bail and Reess discovered and investigated the conditions under which *Mucor racemosus* could become an alcohol-producing ferment. Pasteur showed that some species of *aspergillus*, and what he described as *torula*, were possessed of similar properties, and Brefeld finally set any doubts upon the point at rest by proving that the statement held true for all the mucorini.

Then it was thought possible to restrict the interpretation of the term alcoholic ferment, as applied to fungi, by referring the phenomenon of alcohol production to those fungi which effect their reproduction by sprouting. But this, again, was impracticable, because it was speedily proved that such mode of reproduction is not confined to any specific group of fungi, but is evidenced by many heterogeneous forms. Moreover, it was shown that several of the sprouting fungi cannot provoke alcoholic fermentation at all, whereas indications were not wanting of the capacity of certain hyphal fungi to do so.

The researches which have been conducted upon the chemical composition of the yeast cell have yielded no better result, for although they have shed some light upon the true constitution of a yeast food, and may subsequently assist in determining information respecting the internal structure of the cell, it must be admitted that the information which has been gleaned in this subject is more general than special, and applies more particularly to the chemical constitution of fungi as opposed to other cryptogamia.

It is necessary, in view of these facts, to attach some meaning and some limit to the term "yeast" before its systematic study can be entered upon. Fortunately there is a means at hand wherewith to do this which is of practical as well as theoretical value, because it allows of the inclusion of organisms which are available to the brewer, and rejects the majority of those which are either known or are suspected to be productive of harm. It is based upon observations connected with the mode of propagation of yeast.

It has already been indicated that the propagation of yeast can be effected in two ways —by sprouting or budding, and by the production of spores within the mother cell. The former process is normal to the life of vigorous and healthy yeast; the latter can only be effected under conditions which are decidedly abnormal both to the practices of brewing and distilling. Normal propagation by sprouting takes place in a suitable saprophytic food, such as brewers' wort, though it is even then, to a very great extent, dependent in amount upon other conditions in which the supply or absence of air plays a very prominent part. The discovery of yeast propagation by sprouting dates a long way back. There are some obscure indications of its having been noted by Leuwenhoeck in the year 1680. Doubts are legitimately entertained as to whether the credit of this discovery should be given to this investigator, although it is certain that he was the first to examine yeast under a microscope, which

instrument had, indeed, just been invented about that time. He describes the general morphology and contour of the cells, and his observations, although recorded, were relegated for close upon a hundred and fifty years to the lumber room of the theorist. In the year 1825 the work of Leuwenhoeck was independently confirmed by two microscopists, Caignard de Latour in France, and Schwann in Germany. The sprouting was then observed and described with tolerable accuracy. Moreover, the superiority of instruments over those used by Leuwenhœck allowed of the discrimination of the older cells from the younger by reference to the more granular contents and harder outlines of the former. But Caignard de Latour did more than this. He was aware of the discovery of Black, about the year 1750, that the production of alcohol during fermentation of wort is accompanied by the evolution of carbonic acid gas, and the disappearance or decomposition of the original constituents of the wort, and he made the very pertinent suggestion, "That if yeast could thus ferment sugar, it must surely be by some influence due to its vegetation and its life."

Had his view been accepted, the theories which succeeded it could never have wrought the mischief nor have given rise to the controversy which followed. There is, however, this consolation, that but for the doubt with which the announcement of the propagation by sprouting, and the enunciation of his theory were received, the experiments of Pasteur, by which the truth of both were indisputably substantiated, would possibly never have seen the light. When we reflect that Pasteur's work upon yeast has constituted the corner stone of modern microscopy, has expanded the philosophical conceptions attaching to a nearer acquaintance with the systematisation of nature, and has developed a new school of investigation which has already conferred incalculable benefit upon suffering humanity, we have, in truth, but little reason to regret the result.

Caignard de Latour's views were disbelieved in for two reasons; Ehrenberg, a famous German microscopist, had shown, what is doubtless correct enough, that many mineral and organic substances could, in depositing in a liquid under certain conditions, assume the typical globular form which had been ascribed to yeast without being imbued with life and vegetative functions; and the notion that the life and vegetation of yeast were directly connected with the decomposition of sugar during fermentation was diametrically opposed to the plausible and, indeed, fascinating theory of the illustrious Liebig. Of this theory it will suffice for the present to state that it negatived the possibility of sugar being decomposed, during fermentation, into alcohol and carbonic acid, as a necessary condition to the life and reproduction of yeast in wort. It further negatived the possibility of this decomposition being in any way connected with the sprouting of yeast which Caignard de Latour and Schwann had observed. In place of this theory it substituted one which insisted that instead of yeast growing and vegetating when saccharine fluids were fermenting, it was itself undergoing putrefaction, and that it in this way involved the decomposition of sugar.

This may appear but a trifling theory to refute when we consider it by the light of present knowledge, but in truth it required twenty-two years of the devoted study of a master-mind like Pasteur's before the matter was finally set at rest. The clinching proof may be regarded as that wherein he sowed an infinitesimal quantity of yeast in an artificially prepared solution containing sugar and mineral matter, and produced therefrom a large crop of yeast, the growth of which was shown to take place at the expense of the contained sugar. The difficulties by which his task was surrounded arose chiefly from the possibility of errors creeping in from outside sources. These he succeeded in eliminating, and proved beyond cavil the important fact of the propagation of yeast by sprouting. The rapidity of its growth by this means was fairly astonishing when suitable conditions were secured. Thus, in one experiment, he observed the behaviour of two isolated cells in wort. He watched them continuously under the microscope for two hours, and found that the cells had, in that time, produced six daughter cells by sprouting. From this he made the computation that 16,000,000 cells would have been produced from one cell in twenty-four hours. He further defined the conditions under which this quantity could be vastly increased. For instance, whereas in ordinary circumstances one gramme of yeast was formed at the expense of 100 grammes of sugar, he showed the possibility of producing 25 grammes of yeast at the expense of the same amount of carbohydrate. This observation was of much value to the grower of bakers' yeast, and it should be the subject of more specialised study than it has yet received.

The researches by which he proved the absolute importance of clean plant and pure material in the brewhouse and in the distillery will be sufficiently familiar to you all. He was the first to draw attention to the harm which could be caused by the presence of fortuitous bacteria, which he classed together under the name of "*Ferments de maladie*," and he described numerous specific forms, such as the lactic, the butyric, and the acetic ferment. The value of his advice being promptly recognised in this country, the microscope in due course found its way into every well-regulated brewing room, and there are few brewers now-a-days who would not acknowledge the debt that is due to Pasteur, if this alone had constituted his contribution to the industry.

But although he worked upon yeast with such unflagging patience, he specialised in one direction, and merely indicated broad generalities in others. His task was to crystallise the truth from the many contradictions which enveloped the theory of fermentation; and it demanded all his time and experiments to succeed in this endeavour. He dispelled any doubt which may have existed as to the fact that yeast was a plant. His experiments proved it to be a fungus, but they did not show to what class of fungi it properly belonged. He indicated that it must belong to some specific group in which there were various species, but the group was not located, and its relations to other fungi were barely discussed. His statements were calculated to induce the belief in the mind of a practical brewer that pure yeast meant yeast free from false ferments; and if this freedom were secured, the production of bad beer through any influence created by yeast was out of the question. This view has been proved to be erroneous. It has been shown to be so by a more detailed study of the botany of yeast, and by an accurate examination of the various species into which it has been proved that yeast, which was formerly considered pure, may now be resolved.

It was not necessary for Pasteur to investigate the more technical questions affecting the botany of yeast, because it would not materially have advanced the problem that he set himself to solve. He proved to the satisfaction of his most bitter opponents the truth of his main contentions, and it was the significance of this very proof which tempted him into a fresh field of work, and caused him to leave to others the completion of the task which he had commenced. Fortunately, it has been taken in hand by able investigators, and has yielded results of greater value than could probably have been anticipated.

Reess, a pupil of the eminent fungologist De Bary, had observed, about the time that Pasteur's experiments on yeast were beginning to attract attention, that the form and mode of reproduction of many fungi was in many cases modified by their conditions of nutriment and existence. He found that certain of the mucorini, which in normal circumstances would develop mycelial growth could, by variation in the mode of life, be caused to fructify, and diminish their tendency towards the formation of mycelia.

He was impressed with the conviction, previously entertained by Pasteur, and also by Béchamp, that yeast was a comprehensive form embodying a variety of species. If he could absolutely prove the existence of these species, determine their constancy and their reproduction in their pure state, or if he could in any way induce the formation of mucorini from yeast, then he would be enabled to test the value of the pleormorphic theory, promulgated in its most intense form by Hallier, and supported by such authorities as Karsten, Hoffmann, Bail, Mulder, Wagner, and Meyen. It occurred to him that he would be materially assisted in this endeavour if he could so alter the life conditions of yeast as to cause it to fructify, or, at any rate, to vary its method of reproduction. He was strengthened in his conviction by the assertion of De Seynes, in 1868, that the widely-distributed fungus, *Saccharomyces mycoderma*, could form spores in asci—an ascus being, as previously stated, a large mother cell within which spores are developed. Curiously enough, this observation of De Seynes has been since proved to be entirely wrong, for it has been indisputably proved that *Saccharomyces mycoderma* cannot, as he stated, form ascospores; and the inaccuracy of the observation can only be attributed to the fact that he worked with impure, and therefore unreliable, cultures. When Reess commenced his investigations, he expected to obtain definite information in one of three ways. It would not be possible to effect any change in the mode of reproduction of yeast; it might be that a change, analogous to an alternation of generations, would be produced, which would substantiate the theory of pleomorphism, and elucidate its intricacies; or it might be possible by the discovery of a new method of fructification, and by its aid to limit and

define the number of true yeast species. It was the last of these possibilities which was confirmed by experiment.

The material selected as a substratum for the cultures was a porous vegetable root, as free as possible from sugar, containing much moisture, and capable of freely absorbing more. Slices of well-cleansed potatoes, carrots, and so forth, were found to answer well. A thin layer of moistened yeast was spread upon such a slice and left to itself in a moist atmosphere. In these circumstances reproduction by sprouting takes place but slowly. The daughter cells are characterised by an absence of vacuoles, or have at most only one. They seem to have no tendency to form chains, and it is rarely that more than two are seen together. Yet the reproduction of the yeast by sprouting is appreciable; and if the limits of the original patch of yeast are marked, an outward extension in the course of a day or two will be noticed. After the fourth day, according to Reess, this extension ceases, and the character of the yeast undergoes a complete change. An examination of the yeast discloses some cells which appear to be almost entirely free from internal protoplasm. They soon die and collapse. On the other hand, there are many young cells with many vacuoles, and with the internal contents of the cell in a very granular condition. These young cells show but slight indications of sprouting. It is to them that attention must now be directed. In the course of about twenty-four hours their granulous contents exhibit a tendency towards concentration, and the vacuoles completely disappear. The granules range themselves in the centre of the cell, and constitute separate small islands in its fluid. These are generally from two to four in number, and they are each quickly surrounded by a thin continuous membrane, which completely envelopes each granular nucleus. This is the commencement of the new cell formation. The membrane soon becomes thicker, and the differentiation of each new cell more complete, whilst the only means of identifying the mother cell is by reference to the original cellulose wall, which still envelopes the whole. The diameter of the mother cell has meanwhile increased by about half. If now these cells, that is the mother cells containing the newly-formed cells within them, are introduced into a nutritive wort adapted to alcoholic fermentation, the contained daughter cells sprout, extruding themselves through the membrane of the mother cell, and in due course give rise to new cells by sprouting, which are similar to those with which the experiment of altering the conditions of their life was originally performed. The only variation that is noticeable is that the propagation by sprouting is in such a case somewhat slower than in ordinary circumstances. The cycle of changes is therefore completed, and the constancy of the yeast type under the altered conditions of reproduction is fully established.

Fungologists had little difficulty in recognising this mode of propagation as that of spore reproduction in an ascus, the mother cell developing the spores constituting the ascus; and the observations perfectly correspond to those known to occur in other ascomycetes, in which the asci are small. Indeed, the relationship between this phenomenon and that exhibited by the parasitic group *Exoascus* is so marked as to lead Reess and De Bary to express the belief that yeast which can thus form ascospores is phylogenetically connected with it, and through it with the more highly developed ascomycetes, among which, as previously stated, are included the various well-known species of edible mushrooms. It may be, according to the view expressed by De Bary, that the true yeasts represent the simplest form of ascomycetes from which all the others have been developed; or the alternative view is open, that yeasts are greatly reduced ascomycetes, with extensively interrupted homology, which is only restored with the appearance of the asci. In any case, the relationship of yeast to the ascomycetes was fully established by the ingenious investigation of Reess, and its connection with the mucorini and other groups, as alleged by the pleomorphists, was once and for ever disproved.

It was shown that the ascospores of yeast, when dried, in common with the spores of other fungi, retain for a long time their power of growing.

Reess published the results of his observations in the year 1870, and it was natural that they should have awakened wide-spread interest. His experiments were repeated by Engel, who added to the extraordinary nature of the discovery by showing, in 1872, that moistened plaster of Paris could with advantage be substituted for the slices of roots with which Reess had worked. Brefeld further showed that ascospores could be formed in a moist microscopic object chamber.

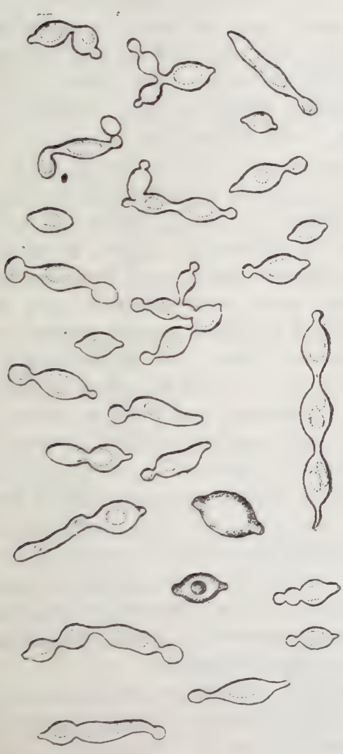
That this spore formation is abnormal to

yeast was proved by Reess, who failed to find it in the many samples, which he examined, which were fit for use either in brewing or distilling; but he found that in brewery specimens which were stale and absolutely useless for alcohol production, he could often determine the presence of ascospores.

This discovery is practically the sum and substance of Reess's contributions; he made many other statements, and he described several new species, which he classed as yeasts. He adopted the name saccharomyces previously proposed by Meyen, and employed by Pasteur as a generic term to distinguish the group. Among those which he described should be mentioned *S. pastorianus*, *S. apiculatus*, *S. exiguus*, *S. conglomeratus*, *S. albicans*, and *S. ellipsoideus*, and he reserved the name *S. cerevisiæ* for the true commercial yeasts.

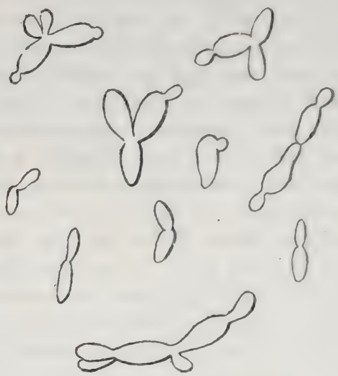
The accompanying illustrations show the form in which the majority of these ferments normally occur when cultivated in saccharine solutions :—

FIG. 6.



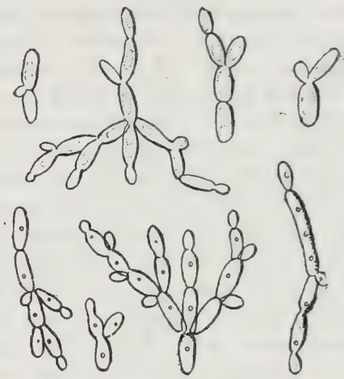
S. APICULATUS. (REESS.)

FIG. 7.



S. EXIGUUS. (REESS.)

FIG. 8.



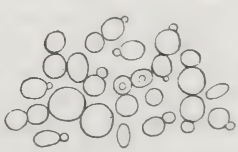
S. MYCODERMA. (REESS.)

FIG. 9.

S. CONGLOMERATUS. (REESS.)

(It is doubtful whether this is a distinct species.)

FIG. 10.



TORULA. (PASTEUR.)

It should, however, be stated in connection with the investigations of Reess that his descriptions were, in many instances, inaccurate, for the very sufficient reason that his experiments were not performed upon pure cultures. Indeed, at the time when his researches were published, the so-called pure cultures had fallen into discredit, and were regarded with disdain by some of the greatest authorities upon the subject. Indeed, Reess laid special stress upon the fact that his cultures were not pure. It remained for others to prove that had they been so he would not have fallen into the error of asserting that many of his species formed ascospores, when, in reality, they do not; that high and low fermentation yeasts were one and the same, subjected to different conditions of life, when in reality they are distinct and true varieties. Nevertheless, it is scarcely fair to Reess to consider his work with reference to its faults; because they are apt to obscure its great and conspicuous merits. If it did nothing else but prove the possibility of yeast developing ascospores, it would still remain as an invaluable contribution to the science of the subject.

The publication of Reess' book, in the year 1870,* may be said to have left the question of ascospore formation in much the same position as Caignard de Latour's research left the matter of yeast sprouting. A great discovery was made, but its significance was not appreciated, nor were its salient features clearly set forth, and the work was involved in much error. It was in this condition when it was taken in hand by Hansen, the director of the physiological laboratory at the world-renowned brewery near Copenhagen.

It is wholly unnecessary to preface a review of his investigations by any words of praise. A fair and unbiased consideration of the study and care they have involved, and the practical results they bid fair to produce, should constitute a far more valuable eulogium than any other that could be passed upon them. His first treatise on the subject was published in the year 1876, although he had for some time previously been perfecting his methods and confirming his experiments. Since then he has devoted himself wholly and uninterruptedly to the task, and has even now, after twelve years of incessant labour, by no means completed it. From this statement some idea may be formed of the difficulties he has encountered.

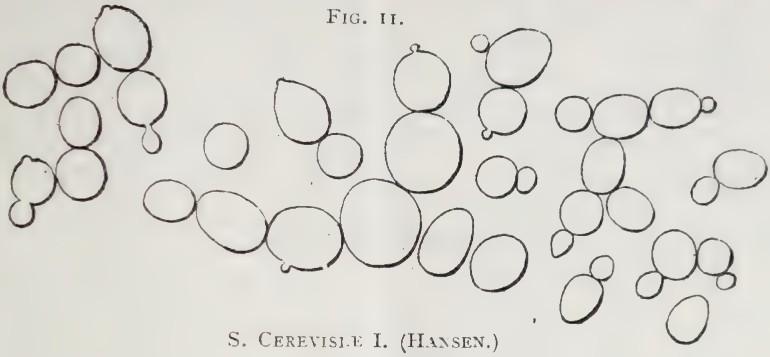
* Bot. Unters. ü.d. Alkoholgährungspilze von Dr. Max Reess, Leipzig, 1870.

His first endeavour was to operate with pure cultures, for he differed altogether from those who denied their value. The method of Pasteur, whereby a sterilised wort was prepared, and cultivations carried on under conditions which prevented the advent of "*ferments de maladie*," were perfect in their way, and Hansen has not modified them in any really essential particular. But once Reess had established the fact that yeast does not represent a transition stage in the life history of a group of fungi, and that saccharomyces constitute a group of their own with typified and definite species, the question naturally arose as to whether varieties of these species might not likewise exist, and whether they might not be capable by their presence of materially influencing the practical workings of the brewer, the distiller, and the producer of bakers' yeast. If, for instance, we take the familiar example of the geranium, we not only see how many cultivated varieties it contains, but what wide and important differences exist between them in point of view of appearance of foliage, of flowers, and of odours. Some are dwarf in growth, others will climb up the side of a house; some have green leaves, others have variegated leaves of the brightest hue; some smell of lemon, some of pepper, and others do not smell at all, and yet they are all geraniums. Now since yeast is a plant, why should it not similarly exhibit varieties with differences as great as those indicated above? Why should these differences not exert a material influence upon the beer, bread, or spirit, which it is instrumental in producing? How is it possible to determine whether such varieties do exist in commercial yeast, whether they exert a deleterious influence on the product, and if so, how may they best be eradicated? To one and all of these questions neither Pasteur's experiments nor those of Reess afford any reliable answer; indeed, it may be regarded as certain that the saccharomyces with which they worked were mixtures of varieties, if not of species, and that although the preponderance of any one of them might, in the Darwinian sense, have tended to crowd out the weaker, still the latter might have remained in sufficient quantity to exercise a marked effect upon the observed results.

It is this reflection which leads us to doubt the value of much of the work that has been done in connection with the chemistry of yeast, since in no one instance have the cultures been pure. The prepara-

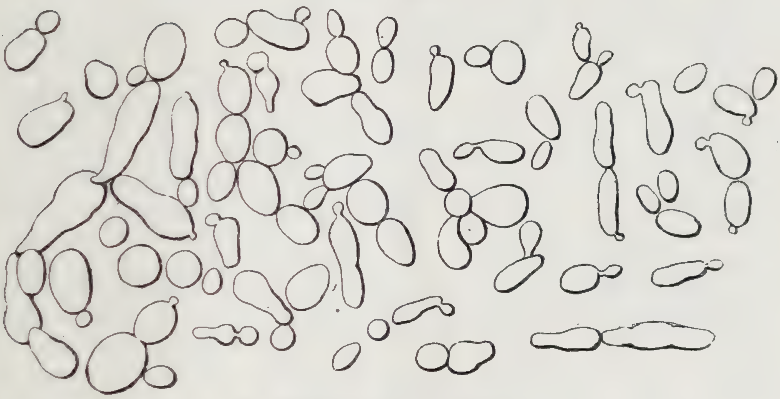
tion of pure cultures was then Hansen's first care, and he has elaborated a system of production which will be fully laid before you. It must not, however, be imagined that the matter had wholly escaped the attention of Pasteur. He refers to it in his *Etudes sur la Bière,* and suggests a method based upon the conception that, if yeast in the form of fine dust be dissipated throughout a sterile atmosphere, and a series of flasks containing sterilised wort be quickly opened and closed in the room in which the yeast has been sprinkled, in some of the bottles, at any rate, a single cell should descend and give rise to a pure culture. This method was uncertain, and did not lead to any significant discovery. As soon as Hansen had obtained his pure cultures (illustrations of which are appended), he

FIG. 11.



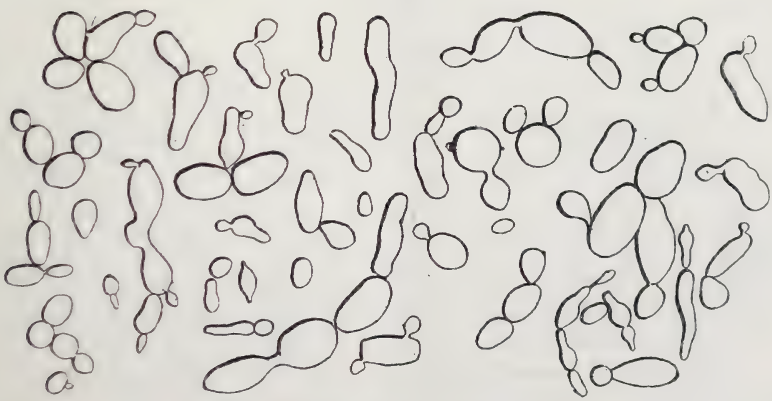
S. CEREVISIÆ I. (HANSEN.)

FIG. 12.



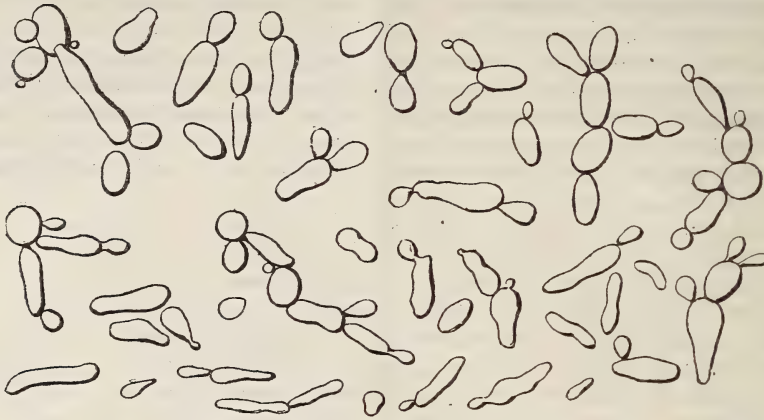
S. PASTORIANUS I. (HANSEN.)

FIG. 13.



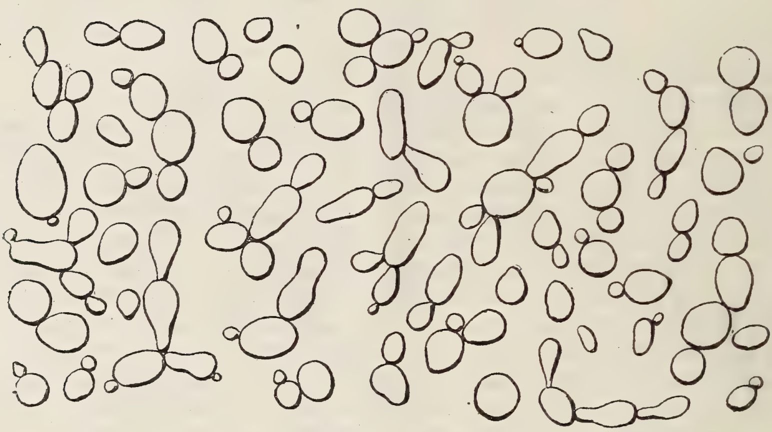
S. PASTORIANUS II. (HANSEN.)

Fig. 14.



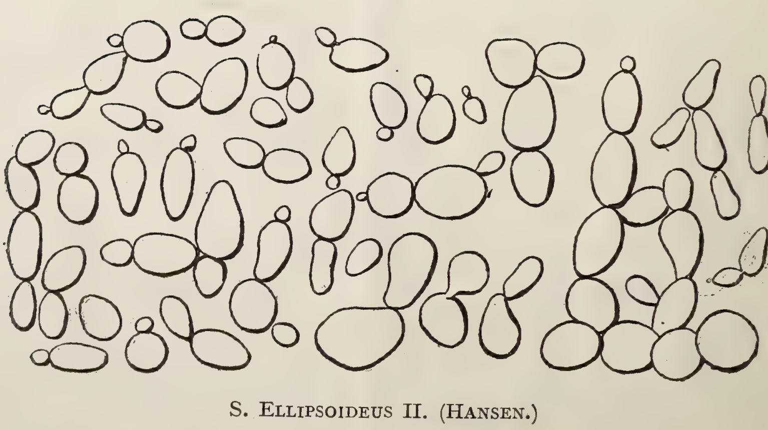
S. Pastorianus III. (Hansen.)

Fig. 15.



S. Ellipsoideus I. (Hansen.)

Fig. 16.

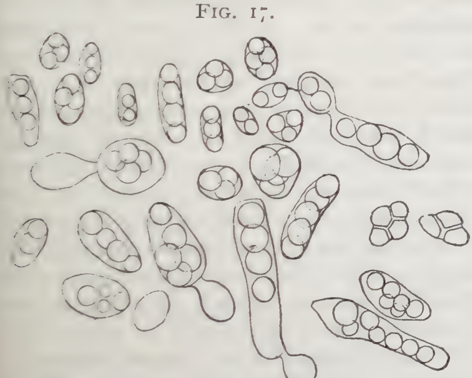


S. Ellipsoideus II. (Hansen.)

promptly made an observation of the utmost importance, and one which showed that the morphology of yeast could not be regarded as a relative index to its true species. He corroborated the statements of previous investigators that there are distinct species of saccharomyces, and these may in some instances be identified by reference to their form and contour. But he showed that, under specific conditions of temperature and growth, one form could be made to assume that of the other. Thus *S. cerevisiæ* could be made to appear like *S. pastorianus* or *S. ellipsoideus*, and his researches made it quite evident that the mere appearance under the microscope might be entirely misleading. Indeed, I may say that I have myself examined in his laboratory pure specimens of his Carlsberg *S. cerivisiæ*, and have observed forms which, without reference to his researches, I should immediately have identified as *S. pastorianus*. I have been favoured with preparations of this which I invite you to examine after the lecture, with the certain conviction that you will endorse what I have said respecting them.

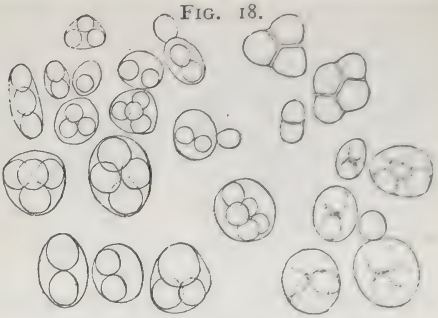
Moreover, when he prepared ascospores according to the method of Engel, from pure cultures, he encountered a similar variety of forms. For instance, the asci, as will be seen by reference to the various diagrams showed that some would develop spores in a pastorianus form of ascus, others in an ellipsoideus form, &c., although they might undoubtedly be derived from pure *S. cerevisiæ*. Hence it became necessary to further investigate the conditions of ascospore formation in order to ascertain wherein consisted the characteristics which allowed of the differentiation of the saccharomyces into their various species and varieties.

FIG. 17.



S. CEREVISIÆ I. ASCOSPORE FORMATION (HANSEN).

FIG. 18.

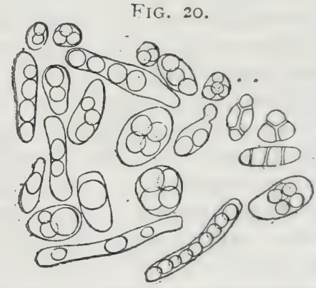


S. PASTORIANUS I. ASCOSPORE FORMATION (HANSEN).

FIG. 19.

S. PASTORIANUS II. ASCOSPORE FORMATION (HANSEN).

FIG. 20.



S. PASTORIANUS III. ASCOSPORE FORMATION (HANSEN.)

FIG. 21.

S. ELLIPSOIDEUS I. ASCOSPORE FORMATION (HANSEN).

FIG. 22.

S. ELLIPSOIDEUS II. ASCOSPORE FORMATION (HANSEN).

He achieved his object by forming ascospores from the various pure cultures at different degrees of temperature. His growths were made on blocks of plaster of Paris in the presence of moisture. His experiments in this direction were varied in every practical way, but in some notable instances he was unable to produce ascospores at all. Eidam, in attempting to repeat Reess's experiments, had failed to produce ascospores from any kind of saccharomyces whatever, and had gone so far as to deny his belief in the possibility of their formation; but Hansen showed him the source of his error in proving that they will only form from young and vigorous cells, and to secure their presence it is advisable to renew the wort from that first employed. Thus he allowed the sample first sown in the wort to vegetate for about twenty-four hours. He then, with all possible safeguards against aërial contamination, poured off the wort from the freshly sprouting yeast, replaced it with a fresh supply of sterile wort, and allowed the yeast to develop for another twenty-four hours. Then he considered that he had obtained fresh and vigorous cells, and he transferred them on sterilised glass scalpels to the sterilised gypsum blocks. These he transferred to incubators kept at constant temperatures, and submitted the samples to frequent examination, so as to detect the appearance of the first rudiments of ascospores. His first experiments were undertaken with S. *apiculatus*. It was a form which Reess, the discoverer, had stated was incapable of forming ascospores, and Hansen confirmed and extended the observation by showing that it was unable to form them at any temperature within the limits of life of this fungus. He also showed that a statement by Engel as to the formation of a new form of organ of fructification, and the origination of a new species by S. *apiculatus*, termed *carpozyma*, was due to inaccurate working, and had no existence in reality. But his experiments upon the effects of temperature when undertaken with pure cultures showed Reess to have made some serious mistakes. Thus he showed that S. *exiguus*, S. *mycoderma*, the so-called *torula* of Pasteur, and other forms stated to form ascospores, do not produce them at all under any conditions at present known. Hence it became apparent that these must, from the fungologist point of view, be as widely different from saccharomyces, which do form ascospores, as other sprouting fungi, such as *Dematium pullulans*, *Chalara mycoderma*, &c.

Indeed, Hansen has proved that, judged by their power of forming ascospores, which is the only really reliable test as yet known to us, we can at present only identify three species as constituting true saccharomyces; they are S. *cerevisiæ*, S. *pastorianus*, and S. *ellipsoideus*. Each of these species is known to form distinct varieties, and they have been designated by Hansen by means of Roman numerals. Thus he calls S. *cerevisiæ I.*, a form of high fermentation yeast, similar to that employed in English and Scotch breweries. He has likewise examined other varieties, and has selected two for use in the Carlsberg brewery for pitching purposes. These he calls Carlsberg yeasts I. and II. Of S. *pastorianus* he has identified three distinct varieties, which are known as Pastorianus I., II., III., and two varieties of S. *ellipsoideus*, known respectively as I. and II.

It should be clearly understood that the species as well as the varieties have been distinguished by variations in the conditions under which they form ascospores; but since it cannot for a moment be doubted that subsequent research will fail to discover fresh species as well as varieties, it necessarily follows that the nomenclature of the group must for the present be regarded as in a transition state. Sufficient has, however, been done to permit of a reliable limit being assigned to the term saccharomyces. It may, then, be provisionally defined as a group of fungi, capable of inciting alcoholic fermentation when introduced into suitable media, capable of forming asci, and developing spores therein under certain defined conditions, and incapable of forming true mycelia. In these circumstances it is clear that the species hitherto included in the group, such as S. *apiculatus*, S. *exiguus*, S. *albicans*, S. *mycoderma*, S. *conglomeratus*, and S. *glutinis* are not saccharomyces at all, and should be re-named when the in-

vestigations now in course of progress are concluded.

Hansen's discovery that the contour of a true saccharomyces is insufficient to determine its species, will show at once how likely it was that Pasteur's experiments were undertaken upon mixtures of species and not upon pure cultures. But a very curious and significant fact remains to be chronicled with respect to this portion of his research. It might at first be supposed that the observations pointed to the feasibility of converting one species into another by propagation of the newly developed forms. This was proved impossible. Thus, by suitable modification of the conditions of growth, *S. cerevisiæ* may be made to assume say the *Pastorianus* form. By sowing the latter under the same conditions, the same *Pastorianus* form may be again developed by propagation. This may be repeated through many generations; but immediately on introducing the last generation into a wort at a temperature calculated to encourage the production of the original *Cerevisiæ* form, it will revert to it, and in the course of a few generations will be undistinguishable from the original *Cerevisiæ* from which it was produced.

So it is with all the other species and all the other varieties. Particularly is it the case with the high and low ferment varieties. Hansen has tried in many ways to convert one form into the other. He has succeeded to this extent: that he has been enabled to make a low ferment acquire the typical attributes of a high ferment; has caused the carbonic acid disengaged during fermentation to attach itself to the cells, and enable the latter to rise through the wort, and having relieved themselves of the gas, to remain like a high ferment upon the surface of the wort. He has been enabled to do this through one generation after another so long as he subjected the yeast to the conditions favourable to the propagation of a high ferment *Cerevisiæ*; but immediately he transferred the new generation of cells thus developed to the low fermentation conditions of temperature and wort, the tendency to reversion was immediately manifested, and ultimately the original variety was fully re-established. It is scarcely necessary to insist that this is strong proof that both species and varieties are true and permanent.

Having thus decided what constitutes a true saccharomyces and what does not, the next question was how to distinguish between the true species themselves. In view of the fact that a microscopic examination in the ordinary way is absolutely useless for this purpose, Hansen determined the limiting temperatures of ascospore formation for each particular species in the manner I have stated. The following were the results obtained in working upon the six species above mentioned :—

SACCHAROMYCES CEREVISIÆ I.

(*High Fermentation.*)

Temp. F.		Time.
100	no development.	
97·0	appearances of distinct rudiments after	29 hours
95·0	,, ,,	25 ,,
92.0	,, ,,	23 ,,
86·0	,, ,,	20 ,,
77·0	,, ,,	23 ,,
73·4	,, ,,	27 ,,
63·0	,, ,,	50 ,,
61·0	,, ,,	65 ,,
52·0	,, ,,	10 days.
48·2	no development.	

The diameter of the ascospores varies between 2·5 — 6 μ. The walls of the spores are generally more distinct than with the other species.

SACCHAROMYCES PASTORIANUS I.

(*Low Fermentation*).

Temp. F.		Time.
89 5	no development.	
85·0	appearance of distinct rudiments after	30 hours.
84·2	,, ,,	27 ,,
83 0	,, ,,	24 ,,
74·0	,, ,,	26 ,,
64·4	,, ,,	35 ,,
59·0	,, ,,	50 ,,
50·0	,, ,,	89 ,,
47·0	,, ,,	5 days
44·6	,, ,,	7 ,,
38·0	,, ,,	14 ,,
33·0	no development.	

The diameter of the ascospores varies between 1·5 and 3·5 μ, rarely to 5 μ. It is often present in the air of fermenting rooms, and corresponds closely with the form described by Pasteur and by Reess. *It has the power of communicating an intensely bitter taste to beer.*

SACCHAROMYCES PASTORIANUS II.

(*Incites a feeble high fermentation.*)

Temp. F.		Time.
84·2	no development.	
81·0	appearance of distinct rudiments after	34 hours
77·0	,, ,,	25 ,,
73·4	,, ,,	27 ,,
62·6	,, ,,	36 ,,
59·0	,, ,,	48 ,,

Temp. F.		Time.
52·5	appearance of distinct rudiments after	77 hours
44·6	,, ,,	7 days
38·0	,, ,,	17 ,,
33·0	no development.	

The diameter of the ascospores varies between 2—5 μ.

This form is also to be found in fermentation rooms, and corresponds in appearance with Pastorianus I. Indeed, if the two were blended, it would be impossible to distinguish them in a microscopic field. *It cannot be shown to exert any ill effects upon beer.*

Saccharomyces Pastorianus III.

(High Fermentation.)

Temp. F.		Time.
84·2	no development.	
81·0	appearance of distinct rudiments after	35 hours.
79·0	,, ,,	30 ,,
77·0	,, ,,	28 ,,
71·6	,, ,,	29 ,,
62·6	,, ,,	44 ,,
60·8	,, ,,	53 ,,
51·0	,, ,,	7 days.
47·0	,, ,,	9 ,,
39·2	no development.	

The diameter of the ascospores varies beteen 2-4 μ.

This variety, although a fairly vigorous high ferment, was obtained from a low fermentation beer. *It has been distinctly proved by its presence to produce cloudy and otherwise defective beer.* In normal circumstances the cells are in all respects similar to Pastorianus I.

Saccharomyces Ellipsoideus I.

Temp. F.		Time.
90·0	no development.	
87·0	appearance of distinct rudiments after	31 hours.
85·0	,, ,,	23 ,,
77·0	,, ,,	21 ,,
64·4	,, ,,	33 ,,
59·0	,, ,,	45 ,,
51·0	,, ,,	4½ days.
45·0	,, ,,	11 ,,
39·2	no development.	

The diameter of the ascospores varies between 2—4 μ. Was found by Hansen, together with other varieties, on the external surface of grapes. Similar in appearance to that described by Pasteur and by Reess, and stated by the former to constitute the ordinary alcoholic ferment of wine.

Saccharomyces Ellipsoideus II.

Temp. F.		Time.
95·0	no development.	
92·0	appearances of distinct rudiments after	38 hours.
91·4	,, ,,	27 ,,
88·2	,, ,,	23 ,,
84·2	,, ,,	22 ,,
77·0	,, ,,	27 ,,
64·4	,, ,,	42 ,,
51·8	,, ,,	5½ days.
46·4	,, ,,	9 ,,
39·2	no development.	

The diameter of the ascospores varies between 2—5 μ. *It has been distinctly proved to be associated with the persistent clouding of beer in which it was present.*

The above temperature results have been expressed by Hansen as curves, and it is in that diagrammatic form that they are most strikingly instructive. I append one Table in which the several curves are embodied. (See p. 1071.)

It is evident that we have herein the elements of a system of analytical classification, for we have it proved:—

1. That all sprouting fungi do not form ascospores under the conditions obtaining in Hansen's experiments.

2. That only the true saccharomyces form ascospores among the sprouting fungi.

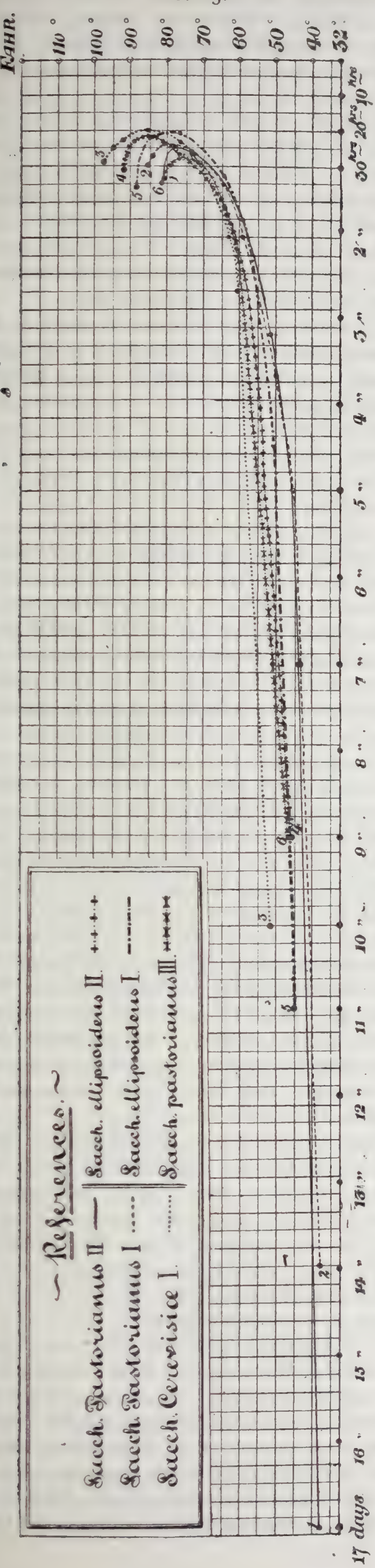
3. That there are certain temperatures at which the formation takes place under the same conditions with varying degrees of speed.

4. That the temperature at which the greatest divergencies with respect to time are manifested — other things being equal — is 11°·5 C. (say 52° F.). Under these conditions *S. cerevisiæ I.* takes ten days to form its ascospores, whereas *Pastorianus I.* and *II.* require less than four days, *S. pastorianus III.* less than seven days, *S. ellipsoideus I.* less than four and a half days, and *S. ellipsoideus II.* less than five and a half days.

The results will, however, not exhibit these divergencies unless the directions are absolutely adhered to; for instance, Hansen shows that the time of ascospore formation will not be the same if the young cells are cultivated in the same wort for two days instead of one before being transferred to the gypsum blocks.

If, therefore, it is desired to ascertain whether a sample of commercial yeast contains *S. pastorianus* I., II., and III., or *S. ellipsoideus* I. and II., it is evident that the information may be afforded by cultivating the

FIG. 23.



yeast as before indicated, selecting a number of single cells and producing ascospores from them at a temperature of about 52° Fahr. If none of the cells form ascospores before ten days, and do so after that interval, we may be certain that the culture is a pure one of *S. cerevisiæ* I. Of course, if it is required to operate upon bulk samples of other species, it might be more convenient to select some other temperature for incubation. This may be best determined by reference to the curve.

Another curious point in connection with ascospore formation is that described by Hansen under the German name of "Scheidewand," and shown in the illustrations (Figs. 17-20), Perhaps the best equivalent English expression would be "jointed formation." It sometimes happens that the spores cling to the wall of the ascus, and adhere somewhat firmly thereto. and can only be detached by shaking. Sometimes, indeed, it needs to be very vigorously shaken before the spores are freed. The conditions of this "jointed formation" may possibly not yet be completely unravelled, and it is by no means improbable that it may subsequently be made available in connection with a more detailed analysis of yeast, when the investigation shall have become extended to all existing varieties.

It will be noticed that a somewhat low temperature is the most favourable to ascospore formation. That is a low temperature for high fermentation *S. ceresiviæ* as compared with its most suitable pitching heat for reproduction by sprouting. There is, however, a limit to be observed, beeause ascospores are not formed at too low nor at too high a temperature.

Hansen is most careful to impress upon brewers the fact that his results only apply to those varieties with which he has actually experimented. If, for instance, an English brewer were to desire to test the purity of his yeast by Hansen's method of analysis, he would have to determine for himsslf the conditions under which he would work, adhere to them most rigidly in every particular, and then ascertain the time required for ascospore formation at a fixed temperature for the particular variety of yeast employed in and suitable for his brewery.

We have now arrived at a stage in our work convenient for adjournment. In the next lecture we shall have to consider some few more investigations with reference to the botany of saccharomyces, and shall then proceed to examine the requirements of a wort suitable for its cultivation.

Miscellaneous.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION, HELD AT BATH, SEPTEMBER, 1888.

By William Henry Preece.
F.R.S., M.Inst.C.E., &c., President of the Section.

(Continued from p. 1057.)

Fontaine showed in Vienna, in 1873, that a dynamo was reversible—that is, if rotated by the energy of a moving machine, it would produce electric currents; or, if rotated by electric currents, it would move machinery. An electric current is one form of energy. If we have at one place the energy of falling water, we can, by means of a turbine and a dynamo, convert a certain portion of the energy of this falling water into an electric current. We transmit this current through proper conductors to any other place we like, and we can again, by means of a motor, convert the energy of the current into mechanical energy to do work by moving machinery, drawing tramcars, or in any other way. We can in this way transmit and utilise 50 per cent. of the energy of the falling water wherever we like. The waste forces of nature are thus within our reach. The waterfalls of Wales may be utilised in London; the torrents of the Highlands may work the tramways of Edinburgh; the wasted horse-power of Niagara may light up New York. The falls of Bushmills actually do work the tramway from Portrush to the Giant's Causeway, and those of Bessbrook the line from Newry to Bessbrook.

The practicability of the transmission of energy by currents is assured, and the economy of doing this is a mere matter of calculation. It is a question of the relative cost of the transmission of the fuel in bulk, or of the transmission of energy by wire. Coal can be delivered in London for 12s. per ton. The mere cost of the up-keep of a wire between Wales and London to deliver the same amount of energy would exceed this sum tenfold. For long distances the transmission of energy is at present out of the question. There can be no doubt, however, that for many purposes within limited areas the transmission of energy by electricity would be very economical and effective. Pumps are worked in the mines of the Forest of Dean; cranes are moved in the works of Easton and Anderson at Erith; lifts are raised in banks in London; water is pumped up from wells to cisterns in the house of Sir Francis Truscott, near East Grinstead; ventilation is effected and temperature lowered in collieries; goods, minerals, and fuel can be transmitted by telpherage.

The transmission of power by electricity is thus within the range of practice. It can be distributed during the day by the same mains which supply currents for light by night. Small industries, such as printing, watchmaking, tailoring, bootmaking, can be cheaply supplied with power. It is thus brought into direct competition with the distribution of power by steam as in America, or by air-pressure, as in Paris, or by high pressure water as in London; and the relative advantages and economies of each system are simple questions of calculation. When that evil day arrives that our supply of natural fuel ceases, then we may look to electricity to bring to our aid the waste energies of nature—the heat of the sun, the tidal wave of the ocean, the flowing river, the roaring falls, and the raging storm.

There is a mode of transport which is likely to create a revolution in the method of working tramways. A tramcar carries a set of accumulators which supplies a current to work a motor geared to a pair of wheels of the car. The weight, price, day's work, and life of the accumulator is curiously the same as the weight, price, day's work, and life of horseflesh; but the cost of maintenance, the liability to accident, and the chances of failure are much less. Although very great improvements in batteries have been made, and they are now really practical things; sufficient experience in tramcar working has not yet been obtained to say that we have reached the proper accumulator. Nor have we yet acquired the best motor and mode of gearing; but very active experiments are being carried out in various countries, and nothing can prevent their ultimate success.

The property which the electric current possesses of doing work upon the chemical constitution of bodies, so as to break up certain liquid compounds into their constituent parts, and marshal these disunited molecules in regular order, according to a definite law, upon the surfaces of metals in contact with the liquid where the current enters and exists, has led to immense industries in electro-metallurgy and electro-plating. The extent of this industry may be gathered from the fact that there are 172 electroplaters in Sheffield, and 99 in Birmingham. The term electro-metallurgy was originally applied to the electro-deposition of a thin layer of one metal on another; but this is now known as electroplating.

In 1839, Jacobi in St. Petersburg, and Spencer in Liverpool, laid the foundation of all we know of these interesting arts. Copper was deposited by them so as to obtain exact reproductions of coins, medals, and engraved plates. The first patents in this country and in France were taken out by Messrs. Elkington of Birmingham, who still occupy the foremost position in the country.

The fine metals, gold and silver, are deposited in thin layers on coarser metals, such as German silver, in immense quantities. Christofle, of Paris, deposits annually, six tons of silver upon articles of use and of art, and if the surfaces so electro-plated were spread out continuously they would cover 140 acres.

The whole of the copper plates used in Southampton for the production of our splendid Ordnance

Survey maps are deposited by copper on matrices taken from the original engraved plates, which are thus never injured or worn, are always ready for addition or correction, while the copies may be multiplied at pleasure and renewed at will.

Nickel-plating, by which the readily oxidisable metals like iron are coated with a thin layer of the more durable material, nickel, is becoming a great industry; the trappings of harness, the exposed parts of machinery, the fittings of cycles and carriages, and innumerable articles of daily use, are being rendered not only more durable but more beautiful.

The electro-deposition of iron, as devised by Jacobi and Klein, in the hands of Professor Roberts-Austen, F.R.S., is giving very interesting results. The dies for the coins which were struck at our Mint on the occasion of the Jubilee of the Queen, were modelled in plaster, reproduced in intaglio by the electro-deposition of copper, and on these copper moulds hard excellent iron, in layers of nearly one-fifth of an inch, was deposited.

The exact processes of measurement, which have led to such vast improvement in our telegraphic system, have scarcely yet penetrated into this field of electrical industry, and little is known at present of the exact relations of current and electromotive force with respect to surfaces of contact, rate of deposit, and resistance of liquids. Captain Sankey, R.E., of the Ordnance Survey Department, has done some very useful work in this direction.

The extraction of metals from their ores by deposition has received wide application in the case of copper. In 1871 Elkington proposed to precipitate copper electrolytically from the fused sulphide of copper and iron known to the copper smelter as "regulus." Thin copper plates were arranged to receive the deposited copper, while the foreign metals, including gold and silver, fell to the bottom of the solution, the process being specially applicable, it was supposed, to regulus containing small quantities of the precious metals.

The electrical purification of copper from impure "blister copper," or "blade copper," has also made great progress, and special dynamos are now made which will, with an expenditure of 100 horse-power, precipitate 18 tons of copper per week. The impure metal is made to form the anode in a bath of sulphate of copper, the metal being deposited in the pure form on a thin copper cathode.

It was not very long ago considered very economical to absorb ·85 horse-power in depositing one pound of copper per hour, but now the same work can be done with ·3 horse-power. Mr. Parker, of Wolverhampton, has done good work in this direction, and his dynamos in Messrs. Bolton's works have revolutionised this process of purification.

Both at Swansea and Widnes immense quantities of copper, in spite of the restrictive operations of the copper syndicate, are being produced by electro-deposition. Copper steam pipes for boilers are now being built up of great firmness, fine texture, and considerable strength by Mr. Elmore, at Cockermouth, by electro-deposition on a rotating mandril in a tank of sulphate of copper. By this process one ton of copper requires only a little more than one ton of coal to raise the requisite steam to complete the operation.

It has been shown that the electrolytic separation of silver from gold by similar methods is perfectly practicable. The value of the material to be dealt with may be gathered from the fact, communicated to the "Gold and Silver Commission" now sitting, that nearly 90,000,000 ounces of silver are annually produced, and the greater portion of this amount contains sufficient gold to render refining remunerative. Although the old acid process of "parting" gold and silver remains practically undisturbed, there seems no reason to doubt that in the future electricity will render us good service in this direction as it has already in the purification of copper.

There is not much actual progress to report in the extraction of gold from its ores by electrical agency. The conversion of gold into chloride of gold by the direct, or indirect, action of chlorine is employed on a very large scale in (Grass Valley) California and elsewhere. This fact has led to well-directed efforts to obtain by electrolytic action, chlorine which should attack finely divided gold suspended (with the crushed ore) in the solution from which the chlorine was generated, the gold, so converted into soluble chloride, then being deposited on a cathode. The process would seem to be hopeful, but is not as yet a serious rival to the ordinary chlorination method.

In the amalgamation of gold ores much is expected from the possibility of keeping clean, by the aid of hydrogen set free by the electric current, the surfaces of amalgamated plates.

It is well known that the late Sir W. Siemens considered that the electric arc might render good service in the fusion of metals with high melting points, and he actually succeeded in melting 96 ounces of platinum in 10 minutes with his electrical furnace. The experiments were interrupted by his untimely death, but in the hands of Messrs. Cowles the electric arc, produced by 5,000 ampères and 500 horse-power, is being employed on a very large scale for the isolation of aluminium (from corundum), which is immediately alloyed (*in situ*) with copper or iron, in the presence of which it is separated.

The heating power of large currents has been used by Elihu Thomson in the United States, and by Bernardos in Russia, to weld metals, and it is said to weld steel without affecting its hardness. It has even been proposed to weld together in one continuous metallic mass the rails of our railways, so as to dispense entirely with joints.

The production of chlorine for bleaching and of iodine for pharmaceutical purposes, the economical production of oxygen, are also processes now dependent on the electrolytic effect of the electric current.

It is almost impossible to enumerate the various general purposes to which electricity is applied to minister to our wants and to add to our comforts. Everyone appreciates the silent efficiency of the trembling electric bell, while all will sooner or later derive comfort from the perennially self-winding electric clock. Correct mean time is distributed throughout the length and breadth of the land by currents derived from Greenwich Observatory. Warehouses and shops are fitted with automatic contact pieces, which, on any undue increase of temperature due to fire, create an alarm in the nearest fire-station; and at the corner of most streets a post is found with a face of glass, which, on being broken, enables the passer-by or the watchful and active policeman to call a fire-engine to the exact spot of danger. Our sewers are likely to find in its active chemical agency a power to neutralise offensive gases, and to purify poisonous and dangerous fluids. The germs of disease are attacked and destroyed in their very lairs. The physician and the surgeon trust to it to alleviate pain, to cure disease, to effect organic changes beyond the reach of drugs. The photographer finds in the brilliant rays of the arc lamp a miniature sun, which enables him to pursue his lucrative business at night, or during the dark and dismal hours of a black November fog of London.

We learn from the instructive and interesting advertising columns of our newspapers that "electricity is life," and we may perhaps read in the more historical portion of the same paper that, by a recent decision of the New York Parliament, "electricity is death." It is proposed to replace hanging by the more painless and sudden application of a powerful electrical charge; but those who have assisted at this hasty legislation would have done well to have assured themselves of the practical efficacy of the proposed process. I have seen the difficulty of killing even a rabbit with the most powerful induction coil ever made, and I know those who have escaped and recovered from the stroke of a lightning discharge.

The fact that the energy of a current of electricity, either when it flashes across an air space, or when it is forced through high resistance, assumes the form of heat of very high temperature, led early to its employment for firing charges of gunpowder; and for many civil, military, and naval purposes it has become an invaluable and essential agent. Wrecks like that of the *Royal George*, at Spithead, were blown up and destroyed; the faces of cliffs and quarries are thrown down; the galleries of mines and tunnels are excavated; obstructions to navigation, like the famous Hell Gate, near New York, have been removed; time guns to distribute correct time are fired by currents from Greenwich at 1 p.m. In the operations for war, both for attack and defence, submarine mining has become the most important branch of the profession of a soldier and a sailor. Big guns, whether singly or in broadside, are fired, and torpedoes, when an enemy's ship unwittingly is placed over them, are exploded by currents of electricity.

An immense amount of research has been devoted to design the best form of fuse, and the best form of generator of electricity to use to explode them. Gun tubes for firing consist of a short piece of very fine wire embedded in some easily fusible compound, while the best form of fuse is that known as the Abel fuse, which is composed of a small compact mass of copper phosphide, copper sulphide, and potassium chlorate. The practice in the use of generators is very various; some, like the Austrians, lean to the high tension effects of static electricity, others prefer magneto machines, others use the dynamo, while we in England cling with much fondness to the trustworthy battery. Since the electric light has also become such a valuable adjunct to war purposes, it is probable that secondary batteries will become of immense service. The strong inductive effects of atmospheric electricity are a source of great danger; many accidental explosions of fuses have occurred. An experimental cable, with a fuse at one end, was laid below low-water mark along the banks of the Thames at Woolwich; the fuse was exploded during a heavy thunderstorm. The knowledge of the causes of a danger is a sure means for the production of its removal, or of its reduction to a minimum. Low tension fuses and metallic circuits reduce the evils of lightning, but have not removed them. Should war unhappily break out again in Europe, submarine mining will play a very serious part, and, paradoxical as it may appear—as has been suggested by the French ambassador, M. Waddington — its very destructiveness may ultimately prove it to be a powerful element of peace.

It seems incredible that, having utilised this great power of nature to such a wide and general extent, we should be still in a state of mental fog as to the answer to be given to the simple question—What is electricity? The engineer and the physicist are completely at variance on this point. The engineer regards electricity, like heat, light, and sound, as a definite form of energy, something that he can generate and destroy, something that he can play with and utilise, something that he can measure and apply. The physicist—at least, some physicists, for it is difficult to find any two physicists that completely agree with each other—regard electricity as a peculiar form of matter permeating all space as well as all substances together with the luminiferous ether which it permeates like a jelly or a sponge. Conductors, according to this theory, are holes or pipes in this jelly, and electrical generators are pumps that transfer this hypothetical matter from one place to another. Other physicists, following Edlund, regard the ether and electricity as identical, and some, the disciples of Helmholtz, consider it as an integral constituent of nature, each molecule of matter having its own definite charge, which determines its attraction and its repulsion. All

attempts to revive the Franklinian or material theory of electricity, have, however, to be so loaded with assumptions, and so weighted with contradictions, that they completely fail to remove electricity from the region of the mysterious. It is already extremely difficult to conceive the existence of the ether itself as an infinitely thin highly elastic medium, filling all space, employed only as the vehicle of those undulatory motions that give us light and radiant heat. The material theory of electricity requires us to add to this another incomprehensible medium embedded or entangled in this ether, which is not only a medium for motion, but which is itself moved. The practical man, with his eye and his mind trained by the stern realities of daily experience, on a scale vast compared with that of the little world of the laboratory, revolts from such wild hypotheses, such unnecessary and inconceivable conceptions, such a travesty of the beautiful simplicity of nature.

He has a clear conception of electricity as something which has a distinct objective existence, which he can manufacture and sell, and something which the unphilosophic and ordinary member of society can buy and use. The physicist asserts dogmatically: "Electricity may possibly be a form of matter—it is not a form of energy." The engineer says distinctly: "Electricity is a form of energy—it is not a form of matter; it obeys the two great developments of the present generation—the mechanical theory of heat and the doctrine of the conservation of energy." There must be some cause for this strange difference of views. It is clear that the physicist and the engineer do not apply the term electricity to the same thing. The engineer's electricity is a real form of energy; the speculative philosopher's electricity is a vague subjective unreality which is only a mere factor of energy and is not energy itself. This factor, like force, gravity, life, must, at any rate for the present, remain unknowable. It is not known what force is; neither do we know what is matter or gravity. The metaphysician is even doubtful as regards time and space. Our knowledge of these things commences with a definition. The human mind is so unimpressionable, or language is so poor, that writers often cannot agree even on a definition. The definition of energy is capacity for doing work. We practical men are quite content to start from this fiducial line, and to affirm that our electricity is a something which has a capacity for doing work; it is a peculiar form of energy. The physicist may speculate as much as he pleases on the other side of this line. He may take the factors of energy and mentally play with them to his heart's content; but he must not rob the engineer of his term *electricity*. It is a pity that we cannot settle our difference by changing the term. Physicists might leave the term *electricity* to the form of energy, which is an objective reality, and which the ordinary mortal understands; while engineers would be quite content if speculative physicists and enthusiastic mathematicians would call their subjective unreality, their imaginary electrical matter, by some other term. If it be necessary to mentally create some imaginary matter to fulfil the assumptions and abstractions of their mathematical realisations, let them call it *coulombism* or *electron*, and not appropriate the engineer's generic and comprehensive term electricity. The engineer finds the motions of existing matter, and of the ether, quite sufficient to meet all his requirements, and to account for all those phenomena which are called electrical.

It seems parodoxical to assert that two unrealities can form a reality, or that two subjective ideas can become an objective one; but it must be remembered that in all electrical phenomena that which makes them real and objective is derived from without. The motion that renders an electrical phenomena evident is imparted to it from some other form of energy. The doctrine of the conservation of energy asserts that energy is never destroyed, it is only transformed—work must be done to render it evident. No single electrical effect can be adduced which is not the result of work done, and is not the equivalent of energy absorbed. The engineer's notion of work—something done against resistance; and of power—the rate at which this change of condition is effected—are the keystones to the conception of the character of those great sources of power in nature whose direction to the uses and convenience of man is the immediate profession of those who generally assemble together in Section G of the British Association to discuss the "practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipation of Bacon and changed the aspect and state of affairs in the whole world."

I cannot pretend to have given a survey of all the practical applications of electricity. I have but briefly indicated the present area covered by the new and rapidly growing industry. Five million people upon the globe are now dependent on the electric current for their daily bread. Scarcely a week passes without some fresh practical application of its principles, and we seem to be only on the shore of that sea of economy and beneficence which expands with every new discovery of the properties of electricity, and spreads already beyond the mental grasp of any one single worker.

THE THAMES CONSERVANCY BOARD.

The "General Report of the Conservators of the River Thames," from January 1, 1887, to December 31, 1887—ordered by the House of Commons to be printed, July 20, 1888—has been issued (No. 291). The account of the organisation of the Board, with special references to the increase from time to time of its powers to prevent pollution, was given in the

Journal for August 18, 1882 (No. 1552), and the portions of the annual reports which refer to pollution have been at various times noticed. Constituted in 1857 with powers to control navigation, locks, fisheries, &c., it was not till 1866 that it had any power over sewage pollution; but in 1881 the conservators reported "the river above the intakes of the water companies is now practically free from sewage contamination." Above the intakes of the water companies means above Hampton and Teddington, to which locality all the intakes, formerly lower down the river, were gradually removed. Subsequent reports have shown more clearly the sense in which the word "practically" was used.

Under the control of the conservators all the towns on the Thames and its tributaries for ten miles each side diverted their sewage with the exception of Staines. The low-lying position of Staines has been put forward as the difficulty this town has to contend with in complying with the requirements of the Board. The 1886 report alludes to several summary convictions that have been obtained against the local authority there, and last year the report stated "the conservators are instituting proceedings by indictment against the authority, with a view to compelling them to execute the necessary works for the purpose." This last report, however, contains the following paragraph:—"Excepting from the town of Staines, and some minor instances which are being remedied, there is practically no pollution passing into the river above the intakes of the water companies. . . . The conservators indicted the Staines urban sanitary authority in the Court of Queen's Bench." It is stated further that the facts are admitted by the authority, and a case "is now pending before the court for Crown Cases Reserved for the settlement of the points of law in the matter." Nearly all the reports, as this does, refer to "minor instances" in which action is being taken. The conservators allude to the fact that the supervision exercised by its officers is so strict that no pollution can take place without their knowledge.

A new source of pollution is for the first time mentioned, that from house-boats and steam launches. Notices have been served on the owners, and the officers of the conservators have received instructions to keep a strict watch. The conservators state "they have reason to believe" that these steps have led, in the majority of cases, to compliance with the Thames Preservation Act, 1855.

Among other matters it is mentioned that the new cut and weir at Shepperton are complete, and steam dredgers are deepening the navigable channel between Putney and Staines.

The number of convictions for throwing rubbish and ashes into various parts of the river was 45 for the year. Turning to previous reports it will be seen that in 1884 there were 14; in 1885, 41; in 1886, 40. The increase to 45 may be due to increased vigilance, or to increase in the actual number of offences.

In the second part of the report, which deals with the "Upper Navigation," one paragraph refers to the continuation of the works undertaken in conjunction with the Thames Valley Drainage Commission.

By arrangement with five of the water companies the conservators will in future have more funds at their disposal, which hitherto have been inadequate.

PREPARATION OF YEAST IN JAPAN.

Professor Georgeson, of the Imperial Agricultural College at Tokio, in a report upon the preparation of *Koji*, or yeast, in Japan, says that there appears to be some diversity in the methods of preparing this ferment. It is made both in the *sake* breweries and in special *Koji* factories, and while the chief features are alike in all cases, the details in the manipulation are varied to suit the accommodations of the works. In *Koji* factories the fermenting rooms are usually some 15 or 20 feet under ground, in some sufficiently dry place, egress being had by means of a shaft; while in *sake* breweries these chambers are frequently arranged in ordinary buildings, the walls being lined with straw mats and mud, to prevent radiation. The materials used are water, rice, and *tane* (seed or leaven). The rice usually used is the common starchy kind known as *uruchi*. Glutinous rice (mochigome) is never used. The *tane*, which is a most important constituent, consists of the spores of a fungus, *Eurotium oryzeæ Ahlb*, and occurs as a yellow powder, which in a certain stage of the proceedings is mixed with the rice. It is the substance which, in germinating on the rice grain, changes part of the starch into dextrose and dextrine, and gives it the properties of a ferment. The rice is first thoroughly cleaned, that is the thin covering of the seed is removed. It is maintained that if not removed the liquids with which the *koji* is mixed are inclined to putrify. The rice is next washed by stirring it in a tank until all dust and adhering fine particles are floated off, after which it is steeped for some hours to soften the grain. The steaming may be done in the ordinary way by means of a steam boiler, but usually the method followed is of a more primitive nature. A large pot is fixed over a furnace and filled with water. Over the mouth of this pot is fitted a tall wooden tub with double bottom, in which the rice is placed and covered with a lid. The bottom on which the rice rests is perforated with numerous holes, and covered with a thin cloth, to prevent the grain from falling through them, and the lower bottom has one or more large holes. The steam generated from the boiling water, in thus passing through this apparatus, has the desired effect upon the rice. The steaming completed, the rice is spread on straw mats to cool, and soon after, when the temperature has fallen to 98° Fahrenheit, the

above-mentioned fungus spores or *tane* are sown upon the mass, and thoroughly mixed with it. The exact quantity of spores used is not of so great importance as is their thorough and uniform distribution. After mixing the spores with rice, the mass remains in bulk for eighteen to twenty hours, being merely covered with mats, and at this stage the temperature of the room is kept low. The following day the rice is distributed into shallow wooden trays, each holding about three litres, and spread in a thin layer on each. These trays are the carried to the warmest room, where the minimum temperature should not be lower than 75° Fahr., and placed on shelves, or piled one on the other on the floor. In some cases the rice is sprinkled with water and left standing in baskets for some hours before it is placed on the the trays. In other cases the trays are not deposited in the warm room till towards the evening of the second day (the day after sowing the *tane*), and they are then left undisturbed till early in the morning of the third day. In the former case—that is when the rice is not moistened previous to being put on the trays—the latter are left standing only four or five hours, when the contents of each must be thoroughly stirred by hand, which process is again repeated after another four hours of rest, the second stirring occurring thus towards the evening of the third day. At this stage the fungus grows rapidly, and much heat is evolved; the grain becomes opaque, assuming a fibrous texture on the surface, and becomes somewhat sour in taste. It now depends upon the condition of the mass whether there is danger of the temperature rising too high if left over night. If that should be the case, then the trays are emptied of their contents about four and a-half hours after the last stirring, and the rice spread thinly on mats to cool. Should it, on the other hand, be deemed safe to leave it in the trays over night, these are emptied early the following morning, and when the mass has been cooled on the mats, so as to check the further development of the fungus, it is *koji*. In the event of the rice being moistened before it is put on the trays, and left undisturbed until the morning of the third day, as mentioned above, then the mass is stirred at 5 a.m. on that day, and again at 9 a.m.; and should the development of the plant require a longer time still, then it is stirred once again at 1 p.m., after which it is spread on mats to cool. At each stirring it is rubbed between the hands to separate grains which adhere together, and the workmen also heap it up on the trays, or spread it out in thinner layers, according as the temperature is to be increased or diminished. The maximum temperature attained by the mass during the most active period of growth is about 102° to 105° Fahr., or even a little higher at times. There is a loss of weight during the process of from 10 to 12 per cent. of the rice employed. This is due to the evolution of carbonic acid, which circumstance, in turn, makes the ventilation of the room necessary in order to make it possible for the workmen to stay there. The usual plan is to insert a perpendicular flue which can be opened or closed at will, so that it extends from the ceiling to the outer air, and an incline or horizontal flue which discharges fresh air near the floor.

*GASEOUS FUEL.**

By J. Emerson Dowson, M.Inst.C.E.

At the York Meeting of the Association, in 1881, the author explained an apparatus for making cheap heating-gas by passing steam and air through incandescent fuel. Since then the apparatus has been considerably improved, and the gas made in it has been much used, not only for driving engines but for heating in many industrial processes. The composition of the gas necessarily depends somewhat on the quality of the coal used, and on the condition of the fire; the average composition is much the same, whether the gas is made at the rate of 1,000 cubic feet per hour in a small generator, or at the rate of 15,000 cubic feet per hour in a large one. In 1881, it was necessary for gas-engines to use five volumes of this generator gas for one of ordinary lighting-gas to develop the same power; since then some important modifications have been made in the Otto engines, and it is now necessary to use only four volumes. In 1881 only one engine of 3½ horse-power had been worked with the author's gas, but since then a large number of engines have been worked with it, one indicating 80 horse-power. For more than four years Messrs. Crossley, the English makers of the Otto engines, have used this gas exclusively at their works for an average power of 150 horse-power, and after a careful trial extending over thirty-five weeks they have found that the fuel consumption was only 1·3 lb. per indicated horse-power per hour. At these large works there is no chimney except for the blacksmith's shop. Returns sent by eleven users of Otto engines working regularly in different places with the author's gas, and averaging 35 horse-power each, show an average fuel consumption of about 1·3 lb. per indicated horse-power per hour, which is less than half that required for the best steam-engines of equal power. The results of other tests are given, and, seeing that all have been obtained under practical working conditions, the record is certainly satisfactory. Many letters have also been received testifying to the ease with which the gas plant can be managed.

The author considers himself justified in saying that gas power is now fairly launched in competition with steam power, and he thinks with the late Professor Fleeming Jenkin that eventually the former will to a great extent supersede the latter. The author also thinks it tolerably sure that even better results than those already recorded will be obtained when an engine is really designed to give the best

* Read before Section G of the British Association at Bath.

effect with generator gas. It is well known that in the Otto engines each new charge of gas is diluted with a portion of the products of combustion from the previous charge, and this answers very well for ordinary lighting gas. But as generator gas, such as the author's, has only about one-fourth the explosive power of the other gas, it is a disadvantage to dilute it with products of combustion, and he feels confident that sooner or later makers of engines will find it expedient to design all engines of large power specially for cheap generator gas. The best fuel to use for making the gas is anthracite, as it does not yield tar or other condensable products, and does not cake in the generator. Ordinary gas-coke can also be used with certain precautions.

Several instances are given of the use of this gas for heating of various kinds. At the Gloucester County Asylum it has been used daily for about five years. All the kitchen work for the staff and inmates is done with it, and there is no ordinary fire in the kitchen. About 300 quartern loaves are baked with the gas every day, at a cost of about 1s. only for fuel. The gas is also used for two 12 horse-power (nom.) Otto engines, which pump water and drive a dynamo for electric lighting. This gas is used on a large cale at the cocoa works of Messrs. Van Houtens and Son, Messrs. Cadbury, and Messrs. Russ-Suchard and Co. Messrs. Onderwater and Co., of Dordrecht, use it for heating the drying-chambers in their starch works. Messrs. Guittet, of Herblay, have for some years used it for making varnish, and they not only effect a considerable economy, but they avoid all risk of fire, which is a great consideration in varnish works. This gas is also used by the Société Nestlé for soldering their condensed-milk tins, and more recently it has been adopted by Messrs. Huntley, Bourne, and Stevens, of Reading, not only for soldering but for heating a large number of evens in which japanned and varnished goods are stored. Messrs. Hillman, Herbert, and Cooper use this gas at their Coventry works, and in Germany, for brazing with blow-pipes the joints of bicycles and tricycles, as well as for enamelling. On the continent several firms use this gas for singeing silk yarns and textile fabrics. It is also used by several linen manufacturers in the north of Ireland for stentering, which they formerly did with hot air. The cost of the gas somewhat depends on that of the fuel: but, speaking generally, the equivalent of 1,000 cubic feet of ordinary lighting-gas costs from sixpence to one shilling.

RICE INDUSTRY OF SIAM.

Consul Child, of Bangkok, says that rice is now the great staple commodity of Siam. It has been an article of export since 1856, when the treaty with Siam, then ratified, opened up the kingdom to foreign trade. Prior to that the laws of Siam required that a three years' supply of rice should remain in the country before any was allowed to be shipped abroad. When this law was abolished a demand for rice sprang up, and the natives, learning that it was a cash commodity, commenced planting for export, and the acreage has yearly increased, thousands of Chinese engaging in the business. The demand for land has caused canals to be opened through sections which have lain fallow for centuries, and thousands of acres which were useless now stretch out for miles with fields of grain. The natives use the most primitive appliances in the cultivation of the fields, breaking up the ground with buffaloes and oxen attached to a wooden plough; but the soil is so prolific that the grain grows almost spontaneously. At times the fields require irrigation, the water being easily obtained from the rivers and canals which cross the country in every direction. As the land is level, the water rises and falls with the tide; hence the canals require no locks and are navigable for boats, which do all the carrying, since there are but few waggon roads which are traversed by buffalo carts. The rice fields are laid out in lots of about one-third of an acre each, surrounded by an embankment of earth, from eighteen inches to two feet in height, for the purpose of holding water when the land is being prepared for planting or irrigation—for which the cultivator pays a tax to the Government of a sum equivalent to about fourteen pence per field. To encourage the natives to open up new fields no tax is levied on the land the first five years. When matured, the grain is cut with sickles and stacked like wheat, and when needed is threshed by being trampled upon by buffaloes and oxen, six or eight animals being attached to a post, around which the straw is strewn, and over which the cattle walk round and round until the grain is separated from the straw. The straw is then piled up for the cattle, and the grain is winnowed from the chaff and dirt in a machine—a Chinese invention of a thousand years ago. The rice for export—*Kow Moong* and *Kow Soon*—is brought to the mills at Bangkok to be hulled and then packed up for export. The natives hull their rice for home consumption in wooden mortars with wooden pestles, the latter they work with their feet, though many pound it by hand. There are now fifteen steam rice mills in Bangkok, one in course of construction, and one at Patriew, a city thirty miles west of the capital. The only fuel used in these mills is the husk of the rice. There are two varieties of rice, *Na Moong*, which is sown broadcast over the fields and allowed to mature without further care, and *Na Soon*, or garden rice. The latter is allowed to grow to a certain height and is then transplanted. This is the rice of commerce, and is the best and highest priced of all grades. The daily consumption of rice by the average Siamese family is estimated to be from one to two English quarts.

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CANTOR LECTURES.

YEAST; ITS MORPHOLOGY AND CULTURE.

By A. Gordon Salamon, A.R.S.M., F.I.C., F.C.S.

Lecture III.—Delivered February 13, 1888.

It has been shown by Pasteur that the conditions under which yeast is capable of exciting alcoholic fermentation are referable to defined limits of temperature, and to the presence or absence of a certain amount of free oxygen. Beyond a determinate quantity of the latter, which is necessary to the fulfilment of the vital functions of the plant, it may be stated in general terms that its increase during the growth of yeast is accompanied by a decrease in the alcohol-inciting power of the latter. This, however, is not the only effect which the presence of free oxygen is capable of exerting upon yeast. It can produce a remarkable alteration in its morphological appearance. The observation did not escape the attention of Pasteur, although it is but remotely connected with those problems in fermentation with which he more directly concerned himself. He did not, therefore, do more than notice the point, and it was reserved for Hansen to discover its special significance with respect to the saccharomyces group.

If a preparation containing sugar, such as syrup, jam, or preserves, be exposed to the action of a non-sterilised atmosphere, it will, as is well known, become, in course of time, covered with a coherent film, which will gradually become thicker and tougher until it ultimately assumes the texture of a felt, upon the exterior surface of which patches of green colour soon make their appearance. This felt, as before stated, is composed of interlaced hyphæ, constituting a mycelium from the surface of which spring sporophores bearing the reproductive organs of the particular fungus which has thus developed. The most usual growth in such a case is that of the common mould, *Penicilium glaucum*. It must not, however, be supposed that it is only the moulds, or indeed the mycelial-forming fungi, which can thus develop upon the surface of a suitable liquid. The development is generally that of *penicilium*, because the latter is almost always present in the atmosphere; but if its place were taken by other fungi, they would be capable of manifesting analogous, if not exactly similar, phenomena. Indeed, it has been generally proved that fungi which are capable of forming hyphal — that is true — mycelia can develop in this way. They do not form a thick felt like *penicilium*, but they may cover the surface of the liquid with a thin cohesive veil. The term by which we shall recognise such a formation is that of a "mothering,"* the appearance of which will vary with the organism which gives rise to it; but it may be formed by pure cultures of various fungi, and by cells resembling saccharomyces, and, indeed, by true species of saccharomyces themselves. Of those cells resembling the latter, it has been pointed out by Hansen that it is an error to suppose that the "mothering" of beer, developed when the latter is exposed for a long time to the action of the air, is composed exclusively, as hitherto believed, of *S. mycoderma*, and he has proved that it may contain several distinct species. Moreover, such cells are not necessarily devoid of fermentative power. *S. mycoderma* forms a "mothering" exclusively by means of those cells which are sown upon the surface of the liquid; but *Monilia candida*, which has the power of fermenting cane sugar without previous inversion, can fall to the bottom of the liquid, where the cells incite alcoholic fermentation like bottom yeast; they can then rise to the surface by the aid of the disengaged carbonic acid gas, and can subsequently develop a typical cotton-white "mothering," differing in appearance from those produced by other moulds, excepting *Oïdium lactis* and one or two other particular species. *Torula*, *S. apiculatus*, and *S. exiguus* can also produce "motherings" having specific characteristics.

* This is the nearest technical expression to meet the word "voile" used by Hansen.

Of special interest for us is the discovery that the true saccharomyces, as defined in the last lecture, which do not form true mycelia, can also produce "motherings." The conditions under which they form them have, however, been shown by Hansen to be limited within certain ranges of temperature. In these circumstances they exhibit peculiarities which go far to corroborate the statements which have been made respecting the true and distinct nature of the species and varieties already allotted to the saccharomyces group.

If young and vigorous cells of pure cultures of saccharomyces be introduced into sterilised flasks (preferably assay flasks) containing sterilised wort, and the flask be covered with a double layer of sterilised blotting paper, so that the air can have free access to the interior of the flask, without introducing into it any of its contained germs, it will be noticed that in course of time small flecks or patches of yeast will appear upon the surface of the wort. These flecks, which Hansen asserts have, without doubt, developed from a single cell, will, in course of time, extend, and, uniting, will cover the entire surface of the wort with a film or veil of pure culture, in which the presence of mould or other foreign fungi is impossible. The appearance of this "mothering" in saccharomyces may be hastened or delayed in various ways, but its true appearance is not manifested until the fermentation, with its accompanying frothing, has passed away. Tested by these conditions neither *Torula* nor *S. apiculatus* will form a "mothering." It is found that, as with the formation of ascospores, temperature plays amost important part in the production of the "mothering," and allows of limiting ranges being prescribed for each species. They have been determined by Hansen as follows :—

Limiting Temperatures of "Mothering" Formations.

S. Cerevisiæ I.

Deg. Fahr.			
At 100·4	no formation.		
,, 92	flecks feebly developed after		9-18 days.
,, 81	,,	,,	7-11 ,,
,, 70	,,	,,	7-10 ,,
,, 57	,,	,,	15-30 ,,
,, 43	,,	,,	2-3 months.
,, 41	no formation.		

S. Pastorianus I.

Deg. Fahr.			
At 93·2	no formation.		
,, 81	flecks feebly developed after		7-10 days.
,, 70	,,	,,	8-15 ,,
,, 57	,,	,,	15-30 ,,
At 43	flecks feebly developed after		1-2 months.
,, 39	,,	,,	5-6 ,,
,, 36	no formation.		

S. Pastorianus II.

Deg. Fahr.			
At 93·2	no formation.		
,, 81	flecks feebly developed after		7-10 days.
,, 70	,,	,,	8-15 ,,
,, 57	,,	,,	10-25 ,,
,, 43	,,	,,	1-2 months.
,, 39	,,	,,	5-6 ,,
,, 36	no formation.		

S. Pastorianus III.

Deg. Fahr.			
At 93·2	no formation.		
,, 81	flecks feebly developed after		7-10 days.
,, 70	,,	,,	9-12 ,,
,, 57	,,	,,	10-20 ,,
,, 43	,,	,,	1-2 months.
,, 39	,,	,,	5-6 ,,
,, 36	no formation.		

S. Ellipsoideus I.

Deg. Fahr.			
At 100·4	no formation.		
,, 92	flecks feebly developed after		8-12 days.
,, 81	,,	,,	9-16 ,,
,, 70	,,	,,	10-17 ,,
,, 57	,,	,,	15-30 ,,
,, 43	,,	,,	2-3 months.
,, 41	no formation.		

S. Ellipsoideus II.

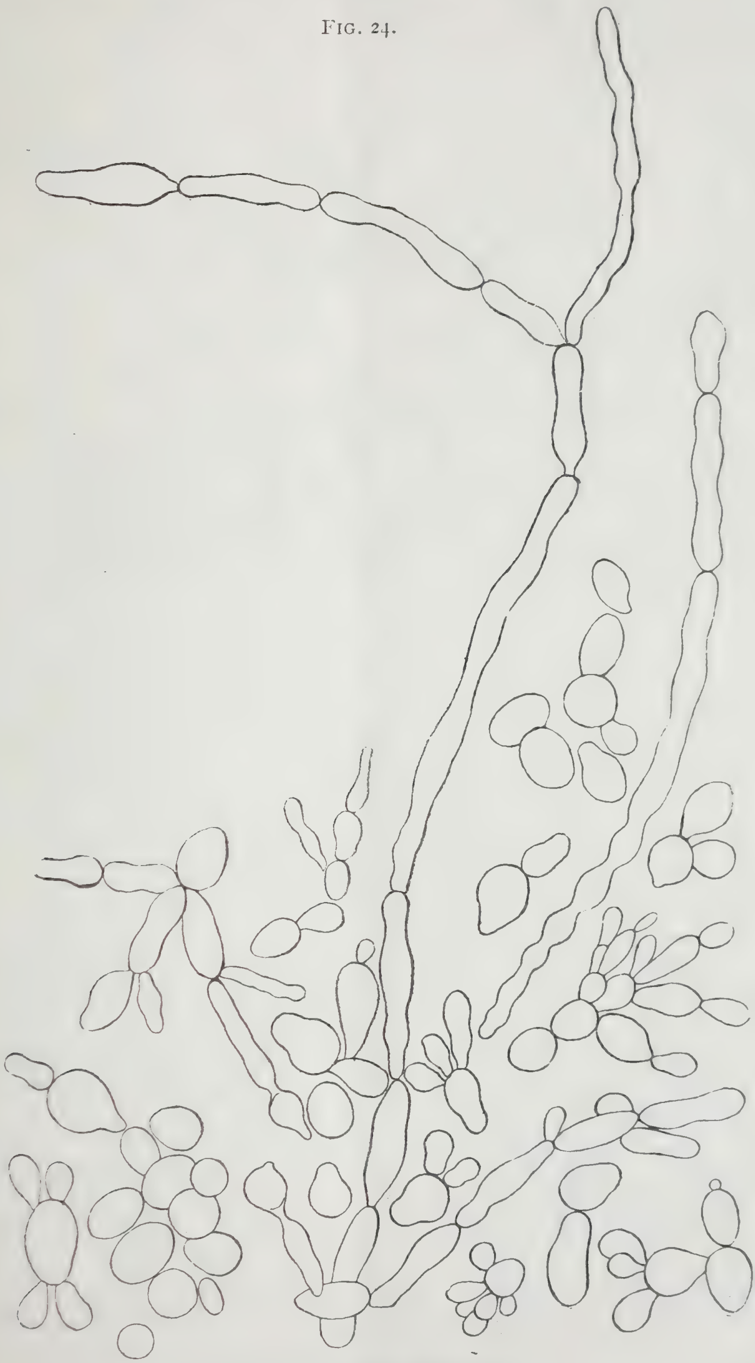
Deg. Fahr.			
At 104	no formation.		
,, 98	flecks feebly developed after		8-12 days.
,, 92	,,	,,	3-4 ,,
,, 81	,,	,,	4-5 ,,
,, 70	,,	,,	4-6 ,,
,, 57	,,	,,	8-10 ,,
,, 43	,,	,,	1-2 months.
,, 38	,,	,,	5-6 ,,
,, 36	no formation.		

These observations are of the greatest possible assistance in case of doubt as to the identity of any one species. It will be noticed that the greatest divergencies with respect to time are exhibited at the temperature of about 57° F., and in this way it is possible to distinguish *S. pastorianus I.* from *S. pastorianus II.*, whereas by mere reference to their morphology such a distinction would be impossible. The same remark applies to *S. ellipsoideus I.* and *II.*

In general terms it may be stated that those species which sprout at high temperatures require them for their "mothering" formations. It is a significant fact, tending to prove that when fermentation is possible, yeast will not undergo reproduction by endogenous division, that it is scarcely ever possible to

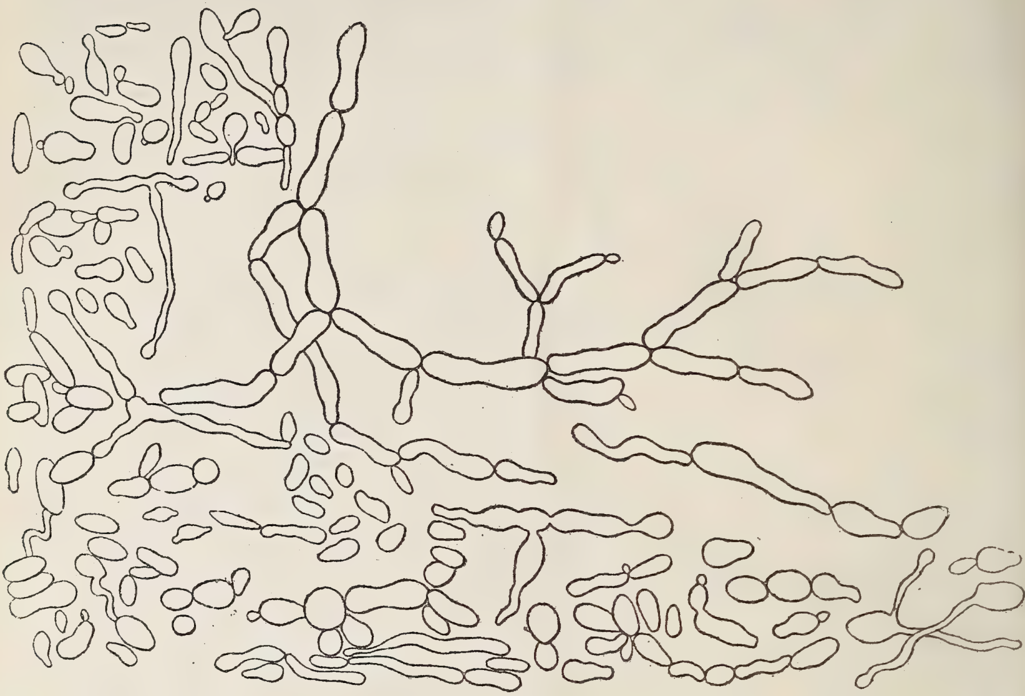
form ascospores from "mothering" cells. The worts in which these "motherings" are formed undergoes a peculiar lightening of colour which is not noticeable in ordinary fermentations. This is, moreover, typical of true saccharomyces "motherings," and is not shared by other species. The morphological appearance of the various "mothering" cells is truly remarkable, and can best be illustrated by reference to the typical illustrations annexed, presented by Hansen with his memoir upon the subject.

FIG. 24.



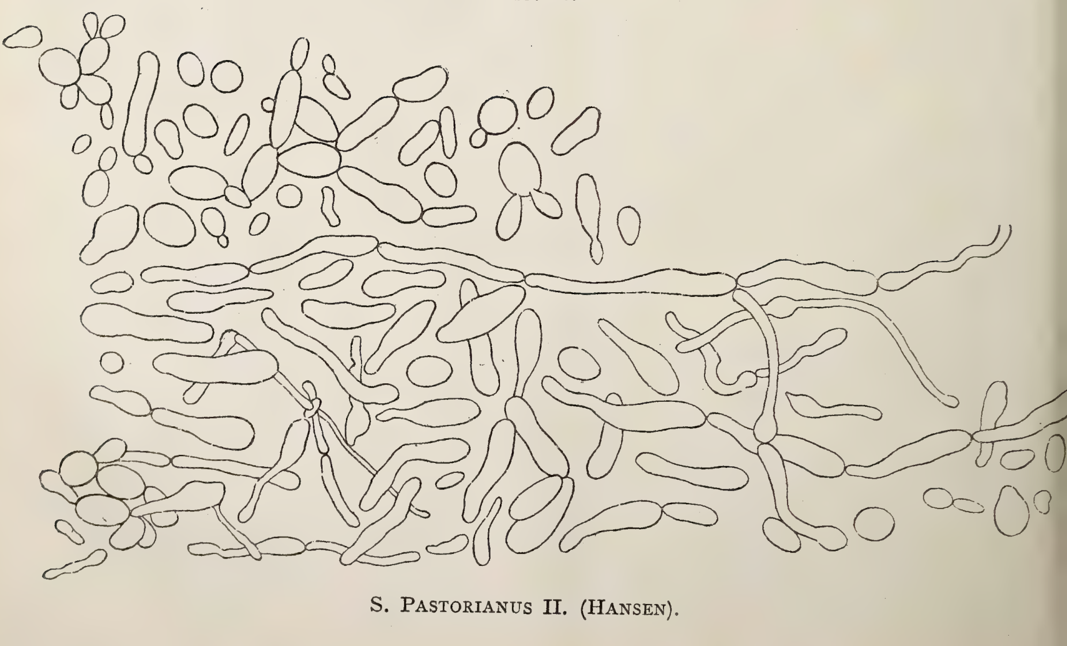
S. CEREVISIÆ I. (HANSEN).

FIG. 25.



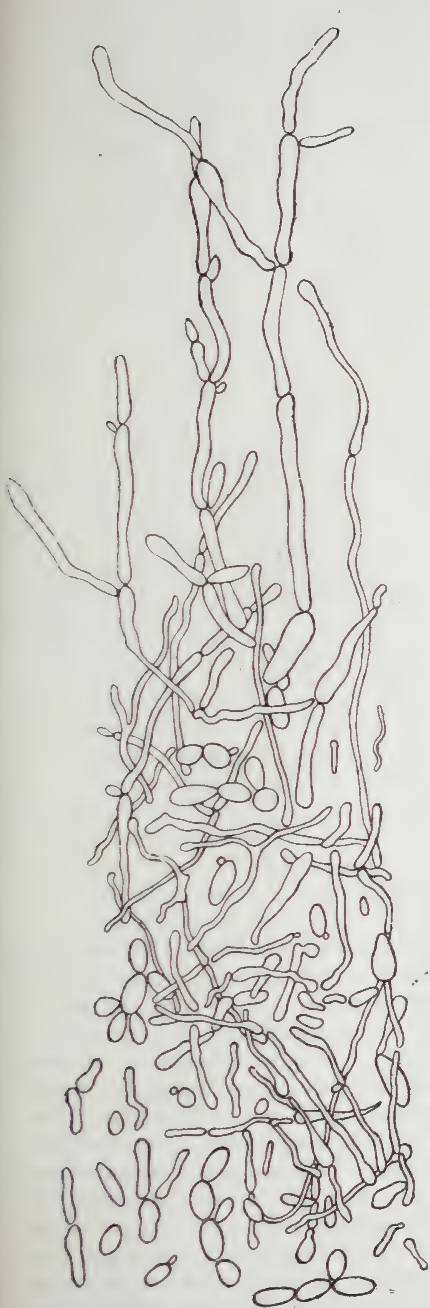
S. PASTORIANUS I. (HANSEN).

FIG. 26.



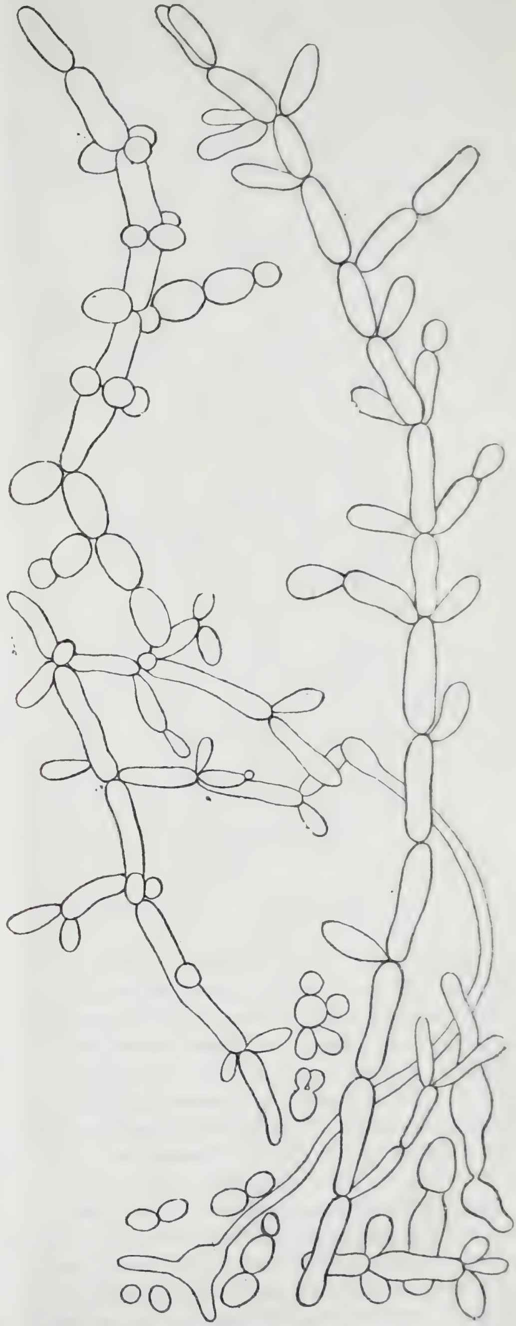
S. PASTORIANUS II. (HANSEN).

FIG. 27.



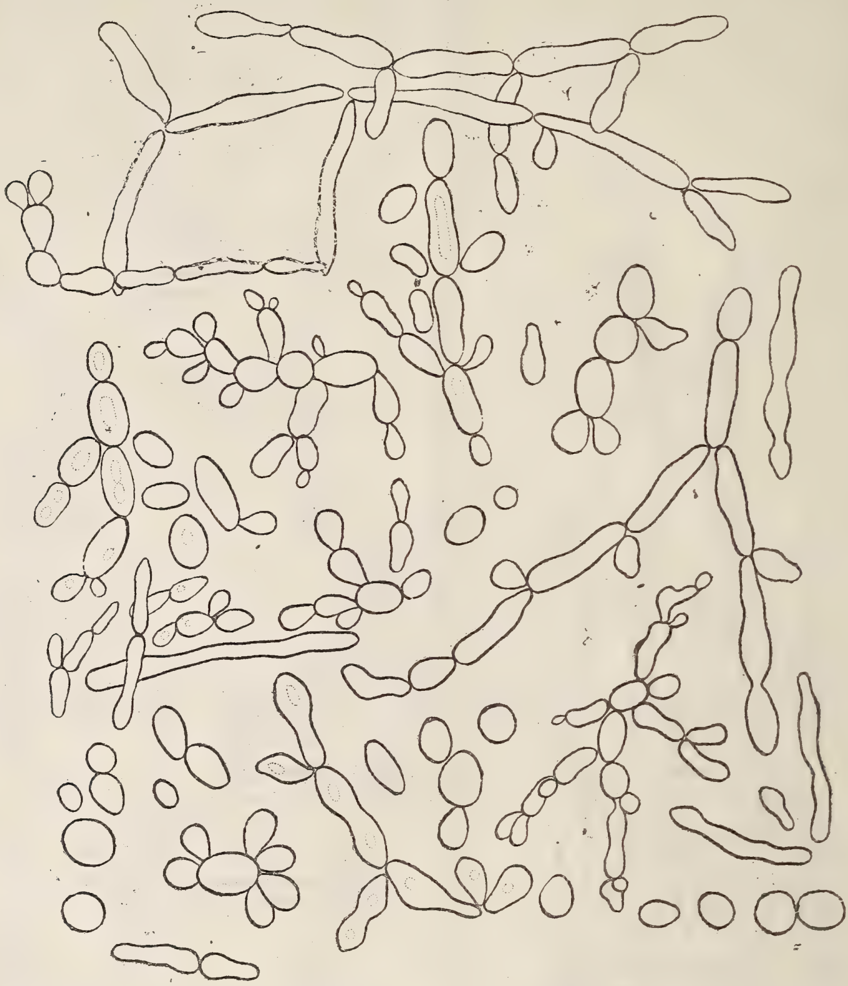
S. PASTORIANUS III. (HANSEN).

FIG. 28.



S. ELLIPSOIDEUS I. (HANSEN).

FIG. 29.



S. ELLIPSOIDEUS II. (HANSEN).

It will be noticed that they differ materially from the mother cells which gave rise to them (Figs. 11-16, pp. 1065-66), and that, although sprouting fungi, they approximate surprisingly in some cases to true hyphal forms. Most remarkable is it, however, that the true type is preserved, and the constancy of the species thereby established, from a totally different point of view to that hitherto approached.

It is obviously impossible, within the limits of these lectures, to devote our attention to the full consideration of those species which are without the bounds of our definition of saccharomyces. Having then defined our true species, and having somewhat minutely investigated their general morphology, it next becomes advisable to examine the conditions upon which their healthy nutriment is dependent.

The cellular structure of plant life was first observed as far back as the year 1667, when it was described with an amazing degree of accuracy by Robert Hooke, one of the first Fellows of the Royal Society. Up to that time the conditions upon which plant life depended for nutrition were absolutely speculative. Until the various parts of the machinery had been identified, it was obviously impossible to assign to them any specific functions, but once the existence of what Hooke called "cells" was demonstrated, it was not long before explanations were forthcoming as to their mode of action. Indeed, already in the year 1671 it was asserted by the celebrated botanist, Malpighi, that the green leaves of plants contain the essential organs of nutrition. It required many years to substantiate this

statement—indeed, nearly a century—for it may be said only to have been finally confirmed by the investigations of Ingenhouss, who, in the year 1779, discovered that the carbon of vegetable cells is derived from the carbonic acid of the atmosphere and not from the soil. The existence of chlorophyll was next proved, and its necessity within the limits which have already been insisted upon was demonstrated. Then followed the classic researches of De Saussure, who confirmed the work of Ingenhouss, and extended it by proving the true significance of the root system with respect to the mineral nutrition of the plant.

It was at this stage in the development of the science that Boussingault and Liebig attacked the question. It is difficult to assign an exact date to their specific discoveries, because they extended over 36 years—from 1804 to 1840; suffice it to say that they fully confirmed the work of previous investigators, and by its extension laid the foundations of the science of modern agriculture. It was they who first confirmed the fact that plants cannot exist without the supply of mineral elements, that they are derived from the soil, and that as they are absorbed their place must be taken by a fresh supply if the plant is to thrive. If the soil did not contain the necessary ingredients, it was shown that the deficiency could be made good by the presence of certain salts which the plant had the power of decomposing, with a view to the assimilation of the necessary elements. One result of their experiments was the manufacture and use in agriculture of artificial manures.

It should be borne in mind that the works of all these investigators possess more than a transitory interest for us in our attempt to arrive at what should be the nutriment of yeast; because what is true of plant life in the broad signification of the term necessarily holds good for fungi also. Hence it is important for us to know that plants cannot assimilate the elements if presented to their cells in the free state. They cannot assimilate free nitrogen or free carbon, which must be presented to the cells suitably combined with oxygen, and they will then be decomposed by the cell constituents as and when required. If we except the body chlorophyll, which in all probability contains iron, the ultimate composition of phanerogams is indeed qualitatively almost identical with that of fungi.

In both cases we find that compartively few elements enter into the composition of those complicated bodies which are capable of exerting so remarkable an influence in the economy and life history of plants. These elements are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, lime, magnesia, and potassium. But in the case of plants containing chlorophyll we find one most extraordinary difference. They require a certain amount of iron, *whereas fungi do not require this element at all.* If the iron is present as a mere trace the plant will thrive, if present in anything beyond this it will do harm, and when in excess it constitutes a violent poison to plant life. It has, however, in the following way, been indisputably proved by Gris, and later by Sachs, that this trace of iron is absolutely essential to the production of chlorophyll. Plants may, like fungi, be grown in an artificial nutrient solution. Of course, they require in addition the presence of air and light. The solution of Sachs is typical of that best adapted to promote growth:—

Water	1,000 cc.
Potassic nitrate	1 gramme.
Sodic chloride	0·5 ,,
Calcic sulphate	0·5 ,,
Magnesic sulphate	0·5 ,,
Calcic phosphate	0·5 ,,

But if the solution does not contain a few milligrammes to the litre of a solution of iron salt the leaves of the growing plant will exhibit the disease known as *chlorosis*, will appear white instead of green, will secrete no chlorophyll grains within the protoplasm of the leaf cells, and thus deprived of the conditions of healthy plant life, will in a short time wither and die. If, however, to such a bleached and withering plant growing in an artificial solution free from iron, the merest trace of iron salt be added, either on the leaves or in the solution, for absorption by the roots, the leaves will acquire their normal green colour in about forty hours. In such a solution, containing its trace of iron, the normal cycle of plant life may be traversed. Seeds will germinate, plants will grow therefrom, will develop seeds in due course, and they in turn may give rise to a fresh generation of plants.

Such, then, are the necessary elements of plant life, and the general conditions of fungal nutriment vary but little from them. Nägeli has made a most searching inquiry as to those elements which must of necessity be assimilated before vigorous life in fungi can ensue, and has arrived at the following conclusions:—The elements required in the construction of the organic compounds are the

same as for other plants, but with respect to the requisite mineral matters they differ slightly. They can exist provided the following mineral elements are present—phosphorus, sulphur, one of the series potassium, rubidium, and caesium, and one of the series calcium, magnesium, barium, or strontium. Now, since rubidium, caesium, barium, and strontium are not, so far as we know, met with in fungal nutriment it may be asserted that for mineral elements phosphorus, potassium, and calcium, or magnesium are required. In this they differ from other plants, which have no alternative choice as between magnesium and calcium, but require both at the same time.

The fact that fungi do not require iron, even in traces, for nutriment is not without its significance for us, because knowing as we do the injurious effect its presence exercises upon beer wort, if present in the water, or other materials employed for mashing, and subsequently brought into contact with hops in the copper, we can, without any hesitation, regard its presence in brewing waters as superfluous and objectionable. Our object, therefore, should be to reduce it to a minimum, or, if possible, to effect its complete removal. But Gris' experiments as to the influence of iron upon plant life may teach us something more than this. As we have seen he found that beyond a trace it constituted a poison. My own experiments upon the influence of phosphates upon the fermentation of worts lead to much the same conclusion—a certain quantity is necessary, indeed no continued healthy yeast growth can take place without its presence. This amount is always normally present in worts made from well-grown barley malts—indeed, I have always found that there is more than enough to suffice for the requirements of the yeast; but experiments have also shown me that increasing excess exerts a strongly retarding influence upon the progress of the alcoholic fermentation, and upon the vitality of the yeast—in fact, in every way does more harm than good.

I cannot point to similar experiments with respect to the other requisite mineral elements, sulphur, potassium, and calcium, or magnesium—but I cannot doubt that in their case also an added excess would be injurious. It may be that the limits of quantities advisable with respect to these elements are much narrower than is generally supposed. Making all allowance for the fact that brewers treat their brewing liquors with mineral ingredients with a view to modify the composition of the wort constituents produced in mashing, it must nevertheless be admitted that in this country there is a tendency to exaggerate the mineral treatment of brewery liquors. Within limits it is highly advisable to supply mineral deficiency, but the exaggeration of the treatment is, in my opinion, most objectionable, and cases are within my experience in which it has done much harm.

We have seen that fungi requires carbon for assimilation; they cannot obtain it from gaseous carbonic acid, because they are devoid of chlorophyll; they cannot assimilate it in the free state, probably because the conditions of plant life require that the assimilable elements should be combined with oxygen, and hence the presence of carbonaceous compounds is necessary. The variety of choice is, however, very considerable. The best food is undoubtedly found in sugar, such as glucose and its allied carbohydrates; but providing that the substances are not poisonous and are soluble in water, almost any carbonaceous compound may be employed. The most suitable nitrogenous food is supplied in the form of proteids and peptones, but it may also be obtained from other sources. Thus Nägeli has shown that carbon and nitrogen may be simultaneously assimilated from *acetamide*, *methylamine*, *ethylamine*, *propylamine*, *asparagin*, and *leucin*. There is, however, a selective action in *oxamide* and *urea*. Though containing both carbon and nitrogen, they can supply the latter but not the former. Again, cyanogen compounds cannot supply the nitrogen, but can furnish the carbon, whilst formic and oxalic acids are unsuitable for carbon supply.

This selective appreciation of food is quite as remarkable with plants as with animals, and not only applies to the kind of nutriment assimilated, but also to the quantity. Thus Sachs calls attention to the fact that sea water contains about 3 per cent. of sodic cloride, and only very small quantities of salts of potash, magnesia, and lime, and yet the ashes of seaweeds contain much lime and relatively but little sodic chloride.

The manner in which assimilation is effected renders it necessary that some foreign ingredients, if present, should be absorbed, although they are not required by the plant. Thus elements are often found in plants, such as zinc and silicon, which are now known not to exert any influence in nutritive or vegetative functions. Formerly farmers used to sprinkle

sand with their wheat-seed when sowing, but the teachings of agricultural chemistry have shown them that such a proceeding is so much money wasted, and that the silica is inert.

Having now determined that carbohydrates (preferably sugar), proteids, and peptones, together with mineral matter containing the elements phosphorus, potassium, magnesium, or calcium, and sulphur, constitute the essential nutritive ingredients of fungi, and *inter alia*, of yeast, we are in a position to inquire for what purpose they are required, and what it is that they go to form. This can only be effected in our case by reference to the constitution of the yeast cell, because it is only those elements which are actually necessary to the formation of those constituents which will be assimilated as nutriment. Judged by this test, it is found that all the above-mentioned elements are required for the production of two substances of which the yeast cell is essentially composed, cellulose and protoplasm.

Cellulose is a member of the family of carbohydrates, and has the composition $n(C_6H_{10}O_5)$. It constitutes the cell wall of all plant structure. When in a sufficiently fine state of subdivision to be examined under the microscope, it is coloured blue, like starch, by a solution of iodine; it is turned black by fluoride of boron; and it is completely soluble in an ammoniacal solution of cupric hydrate. It is possessed of a remarkable power of resistance to other chemical solvents, and of extraordinary solidity and elasticity. This latter property is recognisable in the extent to which the mother cell can expand without rupture when forming an ascus to allow of reproduction by endogenous division. The yeast plant, as typifying a simple plant cell, does not depart from the usual role of having its enveloping membrane formed of cellulose; but it exhibits wide dissimilarities from the cellulose of other plants. This has been observed by De Bary, who has shown that the cellulose of fungi is not coloured blue by iodine; that it does not give the characteristic reaction with Schultz's reagent, and that it is insoluble in an ammoniacal solution of cupric hydrate. For these reasons he has distinguished it by the term fungal cellulose. Richter, however, has shown that it has merely to be digested with an 8 or 10 per cent. solution of potash to be converted into normal plant cellulose possessing all its typical reactions. In this way its relationship to the more highly organised cell structure has been established.

Protoplasm is the name given to a liquid substance of slimy consistency, which is an essential component of every organised cell. It is itself endowed with a specific organisation, and is capable, under conditions suitable to its activity, of exhibiting motion. It may be regarded as expressing the lowest and most elementary phase of living matter. It has been termed by Huxley the physical basis of life, and may be said to mark the boundary line between those highly complicated chemical combinations, which, although able to arrange their constituent atoms about one another with reference to some order of symmetry or asymmetry, are nevertheless devoid as a system of the power of constructive increase, and those equally complicated atomic combinations which are endowed with this property in virtue of the exercise of an aggregate of attributes, hitherto undifferentiated and unintelligible. These we have learnt to embody under the name of "life."

Life is unknown without the presence of protoplasm, which is to be found in every organised living cell, whether animal or vegetable. It need not necessarily fill the entire hollow space of each cell in order to exercise its functions, nor does it actually do so. This is more especially the case with elongated cells in which the protoplasm accumulates towards the sides of the cell wall, leaving one or more unfilled spaces which are recognised as vacuoles. Yeast cells are often only partially filled with protoplasm, and in this way vacuoles are usually observable therein; in many cases there are several in one cell.

The enveloping cell membrane is generally an accompaniment to protoplasmic vitality, but it is not an indispensable one. Familiar instances are to hand in the early stages of the life history of some of the myxomycetes, or slime fungi, in which the protoplasm, although unbounded by any cell wall whatever, is nevertheless capable of expressing its vitality in terms of motion and of constructive increase. It can maintain the exhibition of these extraordinary phenomena with unimpaired energy for days together, and it is only when proceeding to the development of spores that it invests itself with a membrane, which gradually acquires the characteristics of fungal cellulose. Such is the case with the well-known flowers of tan (*Æthalinum septicum*). This fungus has one stage in its life history in which it exists as naked proto-

plasm without a cell wall—a plasmodium, as it is called—and in sultry weather, preferably in darkness, it issues forth from the tan which serves as its substratum, and when it emerges into the open it will creep up stems of plants and remain there for days together; or several plasmodia may fuse and form great flat cakes of bright yellow liquid which sometimes weigh many pounds. In the earlier phases of its growth it will re-enter the tan upon exposure to light, but later on it is not so sensitive to its influence.

This substance, so far as can be ascertained, consists solely of naked living protoplasm. It is exceedingly doubtful, however, whether it is one body of definite composition; indeed, it may be regarded as almost certain that it is a mixture of several substances which unite to form an apparently homogeneous body capable of growth, when nourished and maintained at a suitable temperature. Although there may be several compounds entering into its composition, they probably all belong to the same class, and bear a close relationship to those bodies which Mulder has classed together under the name of proteids. They are synonymous with albuminoids, and include the albumin of blood, of egg, fibrin, casein, and the peptones. They contain about 15 per cent. of nitrogen and 1 per cent. of sulphur.

It is a matter of speculation how the protoplasm is built up, whether it is formed from proteids, or whether it is produced synthetically from other bodies. That plants have the power of constituting proteids we have already seen, and to this end they can effect the decomposition of substances containing one or more of the necessary elements. It is for this reason that sulphate of lime, or magnesia, is so easily decomposed in the progress of plant assimilation, and we may regard oxalate of lime, the crystals of which are so commonly met with in the course of fungal development, as a bye-product arising from the assimilation of sulphur in proteid formation.

The manner in which the protoplasm is formed within the plant cell — *i.e.*, the form in which the elements are introduced for assimilation — will probably vary with the character of the plant. It is scarcely probable, for instance, that it will be the same in a chlorophyll plant where the cells are characterised by their interdependence, as with fungi where they are typified by independence. Then, again, the normal character of the food supply has to be taken into account. In a saprophytic food, such as brewers' wort, a partial decomposition has already been effected, and it seems improbable that the proteids which it contains should require to be wholly decomposed to be rebuilt into protoplasm. If, however, the latter can be formed from proteids, and if the final synthesis can be effected within the cell wall, as there is reason to believe is the case, then it follows that of all the proteids it is only the peptones that can directly take part in the formation of protoplasm, because it is they alone of all the proteids that are capable of diffusion through cellulose.

The functions of the other proteids in brewers' wort are, notwithstanding, generally apparent, because they are converted into peptones by molecular cleavage, and the assimilation of water, just as starch is similarly cleft by means of diastase, and converted into sugars. In this connection it is important to draw attention to a difference existing between the assimilating powers of fungi and other plants for nitrogen. In ordinary circumstances the best vehicle for the conveyance of nitrogen to plant cells is in the form of nitrates. Hence it is that they are so largely used for manurial purposes. This is not the case with fungi, and, therefore, with yeast. They cannot assimilate them, and the nitrogen cannot be more favourably presented than as peptone. It has often been stated that the presence of large quantities of nitrates in brewing waters is prejudicial to fermentation, but whilst it is, perhaps, difficult to follow the reason for this statement, and, notwithstanding that there is every reason to doubt its accuracy as it stands, it must be conceded that their presence cannot exert any power for good in connection with the problem of yeast nutrition.

Apart from the fact that protoplasm always contains a small amount of ash when burnt, which may or may not be present as an incorporated impurity, it is invariably found that it contains a certain amount of water, and in proportion as this is withdrawn, it loses its vitality and at length dies. Protoplasm may therefore be regarded as some form of proteid *plus* water. Sachs regards the latter as occupying an analogous position with regard to protoplasm that water of crystallisation does to crystalline bodies. Nassé, and, more recently, Schützenberger, have made some interesting experiments with respect to the hydration of proteids; but hitherto they have been inconclusive.

When we have described the cellulose and

protoplasm of the yeast cell we have arrived almost at the limits of reliable information respecting its internal constitution, for although it is tolerably certain that the term protoplasm expresses an organisation capable of undergoing processes analogous, at any rate, to those of assimilation, digestion, excretion, circulation, and reproduction as we know them in the more highly-developed forms, still we have but few definite facts to guide us to a decision as to the manner in which those processes are performed. We do not know whence is derived the irritability which stimulates the protoplasm to action, and we are ignorant as to the mode of formation of compounds which have been ascertained to exist in the yeast cell, or at any rate, have been separated from its interior. A few points, however, demand attention, because it seems probable that before long they will lead to explanations of at least some of the difficulties with which we are at present confronted.

By means of staining reagents, and more especially of hæmotoxylyn, or solution of logwood, it is possible, as shown by Schmitz in 1879, and later by Hansen, to differentiate from the protoplasmic contents of the yeast cell a granular nucleated mass of exceedingly minute microscopic dimensions, and of varying form. It is surrounded by a watery film of proteinaceous matters, which, although resembling protoplasm, is stated to differ from it in some essential particulars. The watery fluid has been termed *nucleoplasm*, and the aggregate of granules the *nucleus*. Zacharias has found that the latter contains free phosphorus.

Recent observations indicate that more highly developed plant cells may contain many nuclei, hundreds and even thousands, but so far as is at present known the yeast cell is uninuclear. It is almost certain that the nucleus is a potent factor in fertilisation and reproduction, because it is never absent from plant cells during cell formation; indeed, even with the most highly developed forms it is found that in the embryonic and growing stage the cells contain only protoplasm, nucleoplasm, and nuclei. It is probable that they are present in the cells of all fungi, more especially in asci, and it is certain that they are concerned with the formation of daughter cells, some of their functions in this direction having already been observed. Lest the ordinary granular contents of the cell should be mistaken for nuclei, it is perhaps well to add that they are most difficult of detection, and demand the search of an experienced microscopist.

Nägeli and Löw, to whom we are indebted for most of the information at present available respecting the constitution of the interior of the yeast cell, have defined an interior lining to the cellulose membrane. It is very gelatinous in character, and probably exercises some definite function in connection with the cell economy, but its nature is still obscure. When this gelatinous membrane is repeatedly boiled in hot water it constitutes a gummy mucilage, to which Nägeli and Löw have given the name "Yeast mucilage." It is evidently a carbohydrate, though differing in composition from cellulose—an analysis in the dry state having furnished figures approximating to the formula $3(C_6H_{10}O_5 + H_2O)$.

If protoplasm be regarded as a living organisation, and if it be granted that it is capable of supporting it by food assimilation, it follows that it must have the power of effecting numerous reactions and decompositions in order to do so. We may regard fermentation as among the expressions of such reactions and decompositions; and it is reasonable to conclude that fermentation only takes place when the saprophytic food is in immediate contact with the protoplasm, or at any rate, within the sphere of its molecular action. This is Nägeli's view, and if it be correct, it would appear probable that actual fermentation is accomplished within the cell itself. This would satisfactorily account for the fact that compounds, which clearly represent stages in the gradual degradation of the saprophytic food, are always recoverable from the contents of a yeast cell obtained from a fluid in which fermentation is taking place.

In addition to this, fungal cells are provided with means of storing a supply of food material assimilable in case of need, and moreover they, in common probably with all plants, secrete a compound or series of compounds which have the power of so altering the composition of plant food as to render it easily assimilable, if it be not already in that condition. These bodies have been termed soluble ferments. The term is not altogether a happy one, because the effect which they produce is so totally opposed to that of fungal ferments. They act alteratively — that is, they produce a mild and gradual change, and they may effect the addition of one or more molecules of water in pursuance of this power; but they cannot effect radical decompositions, such as the degradation of carbo-

hydrates into alcohol and carbonic acid, and they are not imbued with vitality. Among such soluble ferments are found the diastase and peptonising ferments of plants and the so-called invertin of saccharomyces.

The latter body is secreted by true saccharomyces, and, as is well known, has the power of inverting solutions of cane sugar into assimilable sugars, viz., lævulose and dextrose. This change must not be regarded in the light of a fermentation, but as a preliminary to it. The quantity of invertin contained in the yeast cell is so small as to be scarcely appreciable by the methods at present available for its estimation. But its power of effecting the preliminary preparation of a saprophytic food must not be judged from this standpoint, because it would appear certain that, if necessary, each cell is capable of inverting far more carbohydrate than is required for its own purposes for food. The point is not devoid of practical importance. It is often urged that yeast is weakened by the use of raw sugar in brewing, because it has to be inverted by the invertin of the yeast before it can be rendered available as a yeast food. It is claimed that the energy thereby demanded of the yeast secures its speedy deterioration. I do not for one moment urge the claims of raw sugar over well made glucose, but this reasoning has always appeared to me to require proof, which it is impossible to adduce. On the other hand, I may say that I am acquainted with several breweries in which raw sugar is employed in small proportions without any diminution of yeast energy; indeed, I know of one in which raw sugar has been constantly used, especially in the production of black beer, and there has been no necessity for changing the yeast for upwards of eight years. I must not be understood, because of this assertion, to advocate its use as an entire substitute for inverted or other more easily assimilable sugar, because I am aware of the disadvantage which may attend its employment; I would wish merely to combat the view that within the limits of practice in England, the use of raw sugar is necessarily attended by a weakening of the yeast.

Starch, which is always secreted in some of the interdependent series of phanerogamous plant cells is scarcely ever found in fungal cells, and so far as observation goes, never in yeast. But fat, in varying quantities, is an ingredient of constant occurrence. Its amount varies considerably with different species of fungi, but would seem to bear some ratio to the amount of oxygen needed to sustain life. Why this should be so remains to be explained, but, as a matter of fact, mucorini, which will only grow when in the presence of a free supply of oxygen, abound in fat; whereas saccharomyces which, as we shall see, require comparatively but a small amount of oxygen for development, are very deficient in fat. In the case of the higher plants the fat is demonstrably obtained only from proteids, whereas with fungi, it may be formed either from proteids or directly from carbohydrates. The fat is disseminated in fungi more especially during the vegetative period, in the form of minute globules interspersed about the protoplasm, and often causes the latter to appear granular and cloudy.

The facts to which attention has now been directed in connection with the composition of the yeast cell may be summed up by an inspection of the well-known analysis of Nägeli. It may be that the results here given would vary somewhat had the culture been pure, in the sense which Hansen interprets the term, and that they would also vary for each particular species of saccharomyces, but they will certainly suffice to allow of a general opinion being formed as to its composition. It is as follows:—

		Per cent.
Cellulose and gelatinous membrane forming the cell walls		37
Proteins	(a) Ordinary albumin	36
	(b) Easily decomposable, of the nature of gluten casein	9
Peptone, precipitable by acetate of lead		2
Fat		5
Ash		7
*Extractive matter		4
		100

The mineral matters contained in the ash and the ultimate analysis of the cell may be expressed by the following analyses. The reservations expressed with respect to the figures of Nägeli apply with even more force to these:—

	Top Yeast. (Mitscherlich.) Per cent.	Bottom Yeast. (Mitscherlich.) Per cent.
Phosphoric acid	53·9	59·4
Potash	39·8	28·3
Soda	—	—
Magnesia	6·0	8·1
Lime	1·0	4·3
	100·0	100·1

* Containing bodies not precipitable by acetate of lead, including a substance resembling peptone, small quantities of invertin, leucin, and glucose; still smaller quantities of glycerin, succinic acid, cholesterin, guanin, xanthin, sarcin, and probabbly inosite, with traces of alcohol.

Having somewhat fully discussed the conditions necessary to the formation of a yeast food, it becomes intelligible in what manner malt wort fulfils its essential requirements. This we shall proceed to consider in the next and concluding lecture.

Miscellaneous.

*THE SHIPMAN ENGINE.**

By W. R. Pidgeon, M.A.

This motor is an automatic petroleum-burning steam-engine, and has been designed by Mr. Shipman, of America, for use either on launches or in houses, where a moderate amount of power is required. One of its essential points is that it is automatic, so that when once steam has been generated in the boiler, practically no further attention is required beyond that of opening and shutting the steam valve whenever the engine is started or stopped, the fire, speed, and water-feed being so arranged as to attend to themselves.

The engine is simple or compound, as may be best suited to the work it has to perform, and is built upon the same frame as the boiler. This latter is composed of tubes about 18 inches long, which are screwed into a flat oblong chamber at one end and closed at the other, and is fired externally.

Two small aspirators or atomisers, taking steam from the boiler, suck up the petroleum, which is used as fuel, from a chamber below, and drive it into the furnaces in the form of a fine spray. A couple of torches ignite this spray as it passes inwards, and the flames produced by its combustion rush round and among the boiler tubes. The amount of steam and petroleum that is used by the atomisers is regulated by a diaphragm connected to a valve in the steam-pipe that supplies them.

This diaphragm is exposed to the steam pressure on the one side, and is held down by a spring, loaded to a certain pressure, on the other, and moves upwards or downwards as the steam exerts more pressure than the spring, or *vice versâ*. Its movement is conveyed to the valve by means of a rod, and it thus regulates the amount of steam passing at any moment to the atomisers. In this way the fire is made to vary inversely as the pressure in the boiler, and thus keeps the latter constant.

The petroleum is stored in a tank at any convenient distance from the motor, and is led to it through a pipe having a regulating valve in it. The water in the boiler is kept at a constant level by means of a float, connected to a tap in the suction pipe in the pump. This float is placed in a chamber, which is joined to the top and bottom of the boiler, and rises or falls with the level of the water. The movement is conveyed, through a stuffing-box and by means of levers, to the tap in the suction pipe, which it opens or closes as the water level changes.

The speed of the engine is kept regular by means of a governor, which works directly on to the eccentric, and the lubricating of all journals, cylinders, and slides is performed by the ordinary sight-fed lubricators and cups, except that of the crank-pin, which is effected by means of a centrifugal oiler attached to the crank disc. It may be seen from the foregoing that, when once steam is up, the fires, the water supply, the oiling, and the speed of the engines require no further attention. But, when first starting, a sufficient pressure is required in the boiler to work the atomisers, and for this a hand air-pump is provided. A few strokes of this pump will suffice to start the fires, and it is only necessary to pump slowly for five minutes to raise sufficient pressure of steam to keep them going, fifteen minutes in all being required to get steam up to 100 lbs. per square inch.

As regards the other requirements of small motors, the Shipman engine is compact, not heavy, and simple to understand, so that it neither requires much space, strong foundations, nor a skilled attendant. An engine developing $4\frac{1}{2}$ h.-p. on the brake uses 4·21 lbs. of petroleum per h.-p.; and this, at 7d. per gallon, would give the cost of running at under 3d. per brake h.-p. per hour.

* Paper read before Section G. of the British Association.

FRUIT TRADE OF CALIFORNIA.

The British Consul at San Francisco, in the course of a report on the agriculture of California, refers to the enormous fruit trade of that State. It produces every kind of fruit that grows in a semi-tropical and temperate climate. Among the former are the orange, lemon, citron, shaddock, and other citrus fruits, the olive, pomegranate, fig, banana, apricot, nectarine, walnut and almonds, grapes, producing wine and raisins; belonging to the temperate zone are apples, pears, plums, cherries, peaches, currants, gooseberries, blackberries, raspberries, and strawberries. The green fruit trade of the State has increased enormously. In 1887, the trade in green fruit with the Eastern States amounted to about 35,000,000 lbs. weight. The output of the various canneries in 1886 amounted to about 30,000,000 lbs., including 659,950 cases of fruit, 203,500 of vegetables, and 22,500 of jellies and jams. The estimate for 1887 is 792,500 cases of fruit, with an average of about 45 lbs. of fruit to the case. Of these, 220,000 cases were peaches, 175,000,000 apricots, 150,000 pears, 60,000 cherries, 40,000 plums, 35,000 grapes, 25,000 blackberries, and 15,000 each strawberries and gooseberries. The export of dried and evaporated fruits and vegetables is also enormous. Thus the export

of grapes treated in this way, in 1887, was 16,000,000 lbs., apricots 3,000,000 lbs., honey 1,340,000 lbs., French prunes 1,750,000 lbs., walnuts 1,500,000 lbs., peaches 1,750,000 lbs., grapes 600,000 lbs., apples (evaporated) 550,000 lbs., peaches (evaporated) 1,250,000 lbs., almonds 500,000 lbs., plums 500,000 lbs., and smaller quantities of many other fruits. The growing of grapes for raisins has proved a most profitable crop, with a ready market for all that can be made. Californians believe that their raisin crop will eventually drive the foreign product from the markets of the United States, and from the statistics of the trade the Consul is inclined to believe that they will. The wine production in 1887 was 13,000,000 gallons; 150,000 acres of the State are planted with vines, and not less than 90 per cent. of these are foreign varieties. "That the improvement in the quality of wine produced is very marked there can be no doubt, and the former California wine, with its disagreeable, harsh, foxy taste is fast becoming a thing of the past. This is due to the importation of the best varieties of foreign vines, and a more careful system of cultivation, manufacture, and preservation of the wine." The number of sheep in the State was from 4,000,000 to 4,500,000; the wool clip in 1854 was 175,000 lbs., and in 1876 it had reached 56,550,970 lbs. After this it fell off, and in 1887 was 31,564,231 lbs., but with a great improvement in the quality.

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*APPLICATION OF ELECTRICITY TO THE WORKING OF A 20-TON TRAVELLING CRANE.**

By W. Anderson, M.Inst.C.E.

One of the travelling cranes in the foundry of the Erith Ironworks was originally constructed to be worked by hand, but preparations had been made to apply wire-rope driving at some future time.

The crane is 39 ft. 6 in. span, and consists of a pair of wrought-iron girders resting on end carriages running on an elevated line of rails. The gearing for hoisting longitudinal and for cross traverse is secured on to the top of the main girders, the hoisting chain passes from the barrel at one end, over a pulley at the other, then back to the pulleys in the cross traversing carriage, which runs between the main girders, through a falling block, and thence to an anchorage under the barrel at the extreme end of the main girders. By this arrangement the crane occupies a moderate height, and the hook can come within three feet of each wall.

The inconveniences and wear attending the employment of rope-driving gear induced the writer to try whether electricity might not be used with advantage. Messrs. Elwell Parker, of Wolverhampton, were communicated with, and these gentlemen undertook to supply the dynamo and a motor suitable for the peculiar requirements of a heavy crane. The dynamo, which was intended to give 50 ampères at 120 volts, with 1,200 revolutions, was fixed in the main boiler-house of the works, and was driven by a small horizontal engine by means of a link belt. The leads from the boiler-house up to the conductor in the foundry are of 6 B.W.G. conductor wire, while the conductor is formed of an angle-iron bar, 2 in. $\times$ 2 in. $\times$ $\frac{1}{4}$ in., extending the whole 350 feet length of the shop, and has one face roughly ground and protected from rust by vaseline. The return current travels along one of the rails on which the crane runs. The motor, which is shunt wound, and constructed for 100 volts and 50 ampères, is fixed on the working platform of the crane, beside one of the main girders. Its driving spindle carries a steel pinion which gears into a double helical spur wheel, keyed on to a shaft which runs longitudinally on the top of the girder, and is connected by nests of three bevil wheels, with friction clutch connections to the three shafts which command the several movements of the crane, the means of using the hand-power being still retained.

Two sets of speeds are arranged for each of the movements, namely:—Hoisting, slow 3·4 feet per minute, fast 10 feet per minute; cross traverse, slow 25 feet per minute, fast 105 feet per minute; Longitudinal traverse, slow 78 feet per minute, fast 213 feet per minute.

To provide against undue strains upon the motor an automatic magnetic cut-out is fixed on the crane, and for the purpose of varying the power and speed to meet the requirements of the foundry, a set of resistance coils is provided, governed by a special switch by means of which different resistances can be introduced into the armature circuit of the motor, or the current can be cut off altogether, but so that it must be done by steps, and not suddenly. The connection between the motor and the conductors is by means of brushes pressed against them by elastic attachments. The handles for operating the several movements, the break lever, the switch, and the automatic cut-out, are all collected together, so that a single attendant can readily work the crane from one spot.

The crane was set to work in June last, and has continued to act satisfactorily ever since. The advantages are very great in the facility of adaptation, as it is so easy to transmit the power from any point. The main boilers being always under steam the crane is available at a moment's notice. The duty realised is about 65 per cent. of the power developed in the driving steam-engine. As far as can be judged at present there is no special wear to apprehend. The conductors act satisfactorily, though a considerable length is in the open air, and the dust, heat, and smoke of the foundry do not appear to affect the working.

When first proposed, the writer was not aware of

* Paper read before Section G. of the British Association.

the existence of any other electric crane, but he has since learned that Messrs. Mather and Platt, of Manchester, have had one working satisfactorily for some time, and that there is one also in France.

MATCH INDUSTRY IN EUROPE.

The European countries in which the match industry is most highly developed are France, Sweden, Austria, and Russia. In France this industry is now represented by the *Compagnie Générale des Allumettes Chimiques*, established in October, 1872, and which has the monopoly of manufacture and sale. The *Journal de la Chambre de Commerce de Constantinople* says that by the terms of its convention, renewed with the State for twenty years, from the 1st of January, 1885, the company has to pay to the Government an annual sum of 17,010,000 francs as long as the consumption does not exceed 35,000,000,000 matches; exceeding this amount a larger sum is to be paid. The importation into France of foreign matches is confined to two descriptions, which, however, do not enter very largely into consumption — these are the Austrian wooden matches and the Swedish matches. On an average, 66,000,000,000 of matches are annually consumed in France, of which 55,000,000,000 are wood, and 11,000,000,000 of wax (*allumettes bougies*), which are manufactured in nine factories, situated in diferent parts of the country, and employing, exclusively in their manufacture, more than 7,000 workpeople—male and female—in addition to 12,000 engaged in the manufacture of boxes and in packing. The company uses annually about 2,500,000 kilogrammes (2,455 tons) of cardboard and paper of various qualities in box-making and packing. In the manufacture of wooden matches 45,000 cubic metres of wood are used, 1,500,000 kilogrammes (1,473 tons) of sulphur in sticks, and 300,000 kilogrammes (295 tons) of phosphorus. The wax match manufacture represents an annual consumption of 300 tons of cotton thread, 300 tons of stearine, and 60 tons of phosphorus. The above figures only refer to the matches used in France. The company exports largely to La Plata, Guatemala, Peru, Japan, &c. This exportation represents an annual sum of 15,000,000 francs (£600,000) annually, which, added to the receipts from local consumption, brings the total value of the products of the *Compagnie Générale des Allumettes* up to 80,000,000 francs (£3,200,000) annually, from which the State derives a sum of £1,400,000. There are few countries in which the manufacture of matches is so largely carried on as Sweden, Swedish matches being known all over the world. This country, which in 1865 only exported 1,200 tons of matches, now exports over 10,000 tons, representing a value of nearly £320,000. The Jonkoping factory alone produces annually matches to the value of £320,000, and the value of the production of the other twenty-six factories amounts to about the same sum. The Jonkoping factory employs 1,350 persons, and taking all the factories together, 3,500 workpeople are engaged in this industry. Austria-Hungary is the country in which this industry has been longest established; for a lengthened period she was at the head; but at the present time her production is diminishing. The country still has forty-three large factories and seventy-nine small factories engaged in match-making, the value of the production being £480,000. Russia, with her 416 factories, produced, in 1885, matches to the value of £230,000, and employed 8,945 persons. In Roumania, where the monopoly of matches was established in July, 1886, and put in force on the 1st October, 1887, the Government, which has taken over the manufacture and sale of matches, produced during the period comprised between 1st July, 1886, and the 1st March, 1887, 19,000,000 boxes. In Greece there were imported during the latest year for which returns are available, 14,739,550 boxes, valued at £6,200; and in Turkey, where the match industry is free, but in which country there are no factories, the importation amounted to 10,628,795 packages, representing a value of about £68,000, and in 1885-86 to 9,343,080 packages, valued at about £76,000.

FORESTS OF URUGUAY.

Among the best wooded provinces of Uruguay are Cerro, Largo, Paysandu, Salto, Soriano, Maldonado, and Minas, and the trees of native growth are generally those of a temperate climate. The United States Chargé d'Affaires at Montevideo says that every description of poplars, willows, and alders flourish. Among other trees are the *algarobo*, from the pods of which the natives distil an inferior kind of beer called *chica*. The tree is much prized for timber, and it is stated that cattle thrive upon its buds and foliage. The *umuday* is a lofty tree which is said to resist decay in a most remarkable manner, and Mr. Bacon states that he has seen logs of this tree, said to be over two hundred years old, which evinced no signs of rot. It furnishes immense logs, often sixty feet in length and thirty inches wide. The timbo or canoe tree is valuable for making rough canoes, as the trunk, which is very large and generally hollow, is scooped out, and the rude and frail bark is ready for the fisherman. The *yata* is a tree of exceedingly slow growth, taking over 100 years to mature its fruit, which, like that of the carob tree, is excellent for cattle. The *carrouday* (a large fan palm) is of great use to the poorer native classes, as it makes an excellent roof for their huts, and is easily placed and replaced. The mimosa and cedar grow in great numbers, and this wood is capable of great polish. Among other trees may be enumerated the *lapacho*; the *nanduly*; the *ombu*, resembling a fig tree, but much larger, prized for its shade; the *telane*; the *chanar*, a thorny mimosa, and many others. The absence of the oak, the pine, and the

fir is noticeable, and it is stated that many efforts have been made to grow them, but without success. Of the foreign or imported trees, the eucalyptus from Australia is the most flourishing. There are hundreds of groves of this most flourishing tree in the environs of Montevideo. It is said to be a preventative against malaria, and although extensively grown, there appears to be one objection to it, namely, that it impoverishes the soil around it for many yards, so that no other tree or shrub can flourish in its neighbourhood; and its roots penetrate to such a depth, and entwine every object within their reach to such an extent as to uproot pavements and tombstones, although considerably removed from the trunk of the tree itself.

*ON ROLLING SEAMLESS TUBES FROM SOLID BARS OR INGOTS, BY THE MANNESMANN PROCESS.**

By Frederick Siemens.

The author refers to the circumstance that steel and toughened glass, though specially suitable, on account of their high qualities and strength, for use in the arts, have been somewhat neglected owing to the difficulty of welding and cutting them. Attention is next drawn to the combination of strength with lightness which the tubular form admits of, and to the extensive use of tubes in construction which is likely to follow from a simple means of producing them. The different kinds of rolls hitherto employed which are classed as the longitudinal, circular, and intermediate, are passed in review, and the process which forms the subject of the paper is then described.

In the Mannesmann process a certain relation between longitudinal and rotary motion is maintained, so adjusted for each material to be worked that a twist is imparted to the fibre, resulting in great strength and toughness of the manufactured product. The following is the mode of manufacture:—A bar is placed between conoidal rolls, where the diameter, and therefore the velocity, are least, and is gradually drawn forward into contact with those portions of the rolls which travel more and more rapidly. The rolls are so set that the space left between them for the passage of the bar decreases slightly, so as to cause a certain amount of material to be shifted. The action of the rolls preventing this material from being taken from the outside of the bar, it is consequently drawn from the interior, a hollow being first produced and then a tube.

A mandril may be employed to finish and smooth the interior, and to enlarge the diameter of the tube. That the mandril is not required in the manufacture is proved by stopping the action of the rolls while the bar is passing through them, and breaking off the bar where the hollow is just commencing to form; the metal inside is found to be crystalline and bright, as before being cut there is a vacuum within the hollow, no air, of course, entering during the process of manufacture.

Specimens of tubes made out of Siemens's open-hearth steel, which material is specially suitable for the purpose, were exhibited at the meeting; these show how the tube in the centre commences by a fracture of the metal, which widens out, and also the twist of the fibre having the appearance of a rope, which assists in giving the tubes their great toughness and resisting power.

* Paper read before Section G of the British Association.

General Notes.

Trade in Dog Skins.—Mr. Edgar, the Commissioner of Customs at Newchwang, in Manchuria, in the last Chinese Customs Yellow-book, referring to the trade from that port in robes and mats made of the skins of dogs and goats, says it is generally supposed that dogs are picked up promiscuously wherever they may be found straying, destroyed, and their skins sold to dealers. This, however, is not the case, for although the business may have had its origin in this way, it is now as systematically carried on as sheep-farming. There are thousands of small dog and goat farms dotted over Manchuria and the eastern borders of Mongolia, where from a score to some hundreds of dogs are annually reared on each farm, and where they constitute a regular source of wealth. A bride, for instance, will receive as dowry a number of dogs proportionate to the means of her father. It is probable, says Mr. Edgar, that in no other part of the world are there to be found such splendid dog skins for size, length of hair, and quality, the extreme cold of these latitudes, where the thermometer registers 30° Fahr. below zero, developing a magnificent coat. It is difficult to understand how the dog farmer can afford with profit to rear the animals when the price of the robe is taken into consideration. For one full-sized robe, say 80 in. by 86 in., at least eight animals are required. Putting the price realised at 14s. 6d. for a robe, this would only allow about 1s. 10d. per skin, including the selection—for the skins must match in colour and length of hair—and cost of sewing. The animals are generally strangled in mid-winter, but not before they are eight months old, and then the skins taken in a frozen condition principally to Moukden and Chinchow, where they are cured, assorted, and made into robes, mats, &c. Last year the robes are said to have been decidedly inferior in quality. The reason given is that orders went forward too late, and the farmers, waiting till they had news of some demand, kept the animals alive until their winter coats began to fall off. The value of the trade from Newchwang last year was about £40,000, against nearly £60,000 the previous year. The decline was due to depreciation in value and a decreased demand from the United States.

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CANTOR LECTURES.

YEAST; ITS MORPHOLOGY AND CULTURE.

By A. Gordon Salamon, A.R.S.M., F.I.C., F.C.S.

Lecture IV.—Delivered February 20, 1888.

The investigations which we have so far made concerning the various forms of yeast, its ultimate composition, the constituents of the living cell, the kind of food which it requires, and the mode of combination in which that food must be presented for assimilation in order that vital vigour may be sustained, will have prepared us for an appreciation of the properties of malt as a yeast food, and will further permit of our ascertaining to what extent practical operations should in this respect fulfil the demands of scientific teaching.

It has been shown that the most favourable form of yeast food comprises three essential groups—carbohydrates, proteids, and mineral matter. Of the carbohydrates we have seen that the various sugars are the most easily assimilated, provided they are in a state of solution. The selective action exhibited by yeast in the matter of nutriment extends, however, not only to specific groups of the carbohydrates, but also to the sugars themselves. Of the true saccharomycetes it may be said that maltose and glucose constitute respectively the most suitable carbohydrate combinations, inasmuch as they comply with the most stringent requirements of a saprophytic food. I am not aware of any experiments which have shown that the dextrines are capable of direct assimilation, nor do I believe them to be so, but they are gradually resolvable into maltose by hydrolysis, and hence their utility in providing a continuous supply of maltose during the later periods of fermentation at once becomes apparent.

It is, however, most important to bear in mind that all fungi that are capable of inciting alcoholic fermentation do not comport themselves in the same manner towards sugar solutions. For instance, all the true saccharomyces hitherto described can ferment maltose, but *S. exiguus* and *S. apiculatus* are unable to do so. Herzfeld, and Brown and Morris, have discovered and isolated a compound termed malto-dextrin, an ultimate product of the hydrolysis of the higher dextrines. This compound cannot, according to the statement of the latter investigators, be split up into maltose and dextrin by the action of *S. cerevisiæ*. They do find, however, that it can be thus resolved by the action of *S. pastorianus* and *S. ellipsoideus*, though we have yet to learn which particular varieties of these species are capable of effecting this further degradation. Again, we have seen that a true saccharomyces secretes within its cell a so-called soluble ferment—invertin, which is able, in case of need, to complete the preparation of the saprophytic food by rendering it assimilable. This in the case of cane sugar, which can be thereby modified by the alterative action of the invertin, and converted into the assimilable glucoses, lævulose and dextrose.

But the possession of secreted invertin is not common to all alcohol-producing fungi, and, consequently, they are unable to effect the transformation of cane sugar into glucose. This is true of *S. apiculatus*, and of four out of the five varieties into which Hansen resolved the species of *torula* as described by Pasteur. On the other hand, *Monilia candida*, although not secreting invertin, is enabled to effect the direct alcoholic fermentation of cane sugar. It may be that this is due to the possession of some soluble ferment other than invertin; but upon this point there is, at present, no forthcoming reliable information.

This dissimilarity in the behaviour of the various alcohol-producing fungi towards the carbohydrates is one among the many powerful reasons which lend weight to the argument that in order to ensure uniformity of product upon the commercial scale, the culture of yeast requires to be just as pure as for the purposes of laboratory experiments.

With respect to the choice of nitrogenous

food, yeast is equally selective in character. We have seen that such food preferably belongs to the class of bodies known as proteids, and that if it be assimilated within the cell, as would seem highly probable, it must, so far as at present known, belong to the subgroup of peptones; because, as I have already stated, they are the only class among the proteids which are diffusible, a property which has been shown to be indispensable to fungal nutriment. But proteids are convertible into peptones by means of certain soluble ferments, and in this way proteid food other than peptones is rendered available in assimilation. In ordinary plant life it has been proved that proteid may be manufactured within the cell system, provided that the necessary elements are to hand; and it is certain that it may also be produced from some members of a group of bodies known as amides, a familiar and important example of which is furnished by the substance asparagin. Combination with the necessary proportion of sulphur will convert asparagin into proteid matter, and in this way it and possibly other amides may be of great service in providing nitrogenous fungal food. It would appear highly probable that just as some fungi will ferment maltose, and others will not, so do they exercise a choice in the selection of peptones, both with respect to their ultimate composition and mode of aggregation of their constituent atoms. Of this there is, at present, no direct proof. We do know, however, by practical experience, that in the preparation of beer the presence of certain types of nitrogenous combination is essential, and that of others unfavourable; and there is, moreover, ground for believing that the regulation of the quantity and type of soluble nitrogenous matter in wort will prove to be more in the hands of the maltster than of the brewer, though, perhaps, under the control of both.

It may facilitate the practical application of considerations arising out of these remarks to indicate the necessity which exists for paying more attention than has hitherto been the case to the chemical composition of hops employed in the production of beer-wort, and to emphasize the effect which wort, prepared with hops devoid of certain essential characteristics, may subsequently exert upon the progress of fermentation. In a manner admittedly empirical, the brewer at present knows that some nitrogenous combinations exercise a salutary influence, whereas others are capable of exerting an injurious effect upon fermentations. It is further known that certain of these combinations are precipitated by the tannin of the hops during the process of boiling in the copper, whilst others remain in solution notwithstanding its presence. The brewer's experience teaches him that it is desirable that the wort should "break" well in the copper; and that the precipitation by the tannin should be as complete as possible. Yet he seldom, if ever, inquires whether the variation in the quality or quantity of the hops he employs effects any alteration in this particular direction. Chemical examination, however, reveals the fact that the amount of tannic acid contained in hops is subject to fluctuation within very wide limits, and cases are within my experience in which deficiencies in this respect should certainly have been made good. Moreover, the nitrogenous matters themselves contained in the hop should not escape attention, especially when regarded in connection with the ratio which they bear to the tannic acid present. This subject, suggested to me by Mr. Frank Wilson, is being investigated by my talented pupil, Mr. H. B. Woldridge, and I am confident that the publication of his experiences, when complete, will clear up many points at present obscure.

With respect to mineral ingredients; phosphorus, sulphur, potassium, together with either calcium or magnesium, have been shown to be essentials; others, such as chloride of sodium, may be, and probably are, of vast importance in controlling the production of the proper type of yeast food; but reliable experiments in this direction have yet to be made.

Now when we apply the facts at our disposal concerning yeast nutrition to the consideration of the composition of a normal wort prepared from well-made malt, we find that all the most favourable conditions are obtained. Carbohydrates are in their most desirable form, viz., as maltose and dextrin. Nitrogenous bodies are represented by proteids and amides, and there is an abundant though not an excessive supply of mineral elements.

By suitable regulations of the conditions of mashing the grist, or crushed malt, and that more especially with respect to temperature, it is possible, as brewers well know, to modify the ratio of maltose to dextrin within somewhat wide limits. This variation is of great importance in practice, because undoubtedly, with an increasing amount of dextrin in the wort, there is a greater palatefulness in the resulting beer. The fermenta-

tion is, however, necessarily more prolonged, because dextrin, not being directly fermentable, has first to be converted by hydrolysis into maltose. Hence with a beer containing a high per centage of dextrin there is a gradual accumulation of "condition" as the beer matures. It is therefore both desirable and usual to increase the normal ratio of dextrin to maltose in the case of stock ale. In that, however, of an ale intended to be rapidly brewed and consumed, it is obviously desirable to produce the maximum available ratio of maltose to dextrin. Up to a temperature of about 140° F. the proportion is constant, viz., about 81 parts by weight of maltose to 19 parts by weight of dextrin. Beyond this, within a range of 40° F., there is an increase in the ratio of dextrin to maltose with each accumulating degree of temperature, until at 180° F. there is an end to the process of hydrolysis; in other words, there is no further conversion of starch into maltose and dextrin under the normal conditions of wort production by infusion.

It is true that these facts with respect to the influence of temperature upon the ratio of maltose to dextrin, for which we are indebted to the researches of O'Sullivan, and of Brown and Heron, have been of great practical value to those who have known how to apply them intelligently; but on the other hand, they have been grossly abused by brewers possessed of that small amount of knowledge of the chemistry of fermentation which constitutes it dangerous. Should a brewer, not over ripe in experience, find that his beers are becoming "fretted," or that he has any trouble with his fermentations, the first step he takes is to drop or raise his mashing heats a degree or two, patiently retiring to his brewing-room to await the result of this momentous operation. If he were asked why he had altered his temperatures, in nine cases out of ten he could not give a satisfactory, or indeed an intelligible, answer. I may go further, and say that even if he had by chance done what was right, there are but few who could really explain the *rationale* of the procedure. Without doubt a considerable amount is known about the chemical conditions of mashing, and the value of a correct appreciation and application of that knowledge cannot perhaps be over-estimated. But mashing is but one stage in brewing, and it should not be forgotten that it is but preliminary to the growth of yeast, which is, after all, the chief care of the brewer. It will be found, as a rule, that most English brewers mash upon sound lines, and trouble, when existing, is generally traceable to the yeast or to the other materials employed. Change of yeast, thorough cleansing of apparatus, attention to attemperation—for instance, turning on the "liquor" sufficiently early—and to the degree of attenuation suitable to the wort employed and the beer it is desired to produce, and, above all, insisting upon being allowed to brew with well-made malt and good hops, will, I venture to think, do more real good in overcoming trouble in the brewhouse than any amount of experimental variation in the mashing or sparging heats. My experience prompts me to assert that, in all cases in which bad beer is being produced where it was formerly good, the first step is to obtain pure yeast, the next, well-made malt and good hops, and that it is scarcely ever advisable, in such a case, materially to alter the plan of brewing, which has perhaps been handed down in the particular establishment for generations past, and which in competent hands and with suitable material has yielded results eminently satisfactory.

In connection with malt it is well to bear in mind some valuable experiments conducted by Graham regarding the influence of kiln temperature upon the wort ratio of maltose to dextrin. They show conclusively that this ratio is quite as much, if not more, modified by variation in kiln drying as by alteration in the mashing heats. Hence if a brewer accustomed to use a very high dried malt had planned his brewings to suit it, and was then compelled, owing to injudicious purchase, to brew with a malt finished off on the kiln at a temperature of some twenty or thirty degrees lower, it would naturally follow that he would not get the same fermentations or attenuations as those to which he had been accustomed. It is clear that in such circumstances, which are of daily occurrence, it does but little practical good to modify the mashing heats by a few degrees one way or the other. Moreover, it is a very great inconvenience for a brewer to be constantly altering the conditions of his working. Assuming that this is necessitated by the variable nature of his malt and his yeast, it is obviously of importance to define a scheme which will enable him to maintain the uniformity of both.

In formulating this, let us first of all direct our attention to the malt. Now, granting that the object of the brewer is to secure uniformity of result, that is that one gyle of

beer shall consistently turn out as well as another, that he uses the same heats, the same plant, and the same general conditions of working from day to day, it necessarily follows that in order to obtain the desired uniformity of product he must work with a raw material that is within narrow limits, constant in its composition and its properties. My own experience justifies the assertion that these conditions are seldom fulfilled by the general run of malt for sale as made in this country.

In order to test the accuracy of this statement, it is necessary to determine a satisfactory series of standards by which the malt shall be analysed and judged. The object of the maltster in preparing barley for the mash tun is, in the main, two-fold. He seeks, by suitable germination of the barley, to develop the formation within the grain of a soluble ferment termed diastase; and, further, so to modify the physical properties of the starch cells of the barley, that after the latter are malted, crushed, and suitably infused with water, they shall be readily gelatinised and broken, so that their granulose contents may escape and be rapidly acted upon by the diastase which has been formed. The action of diastase in effecting starch transformation is similar to that of all soluble plant ferments. It is alterative, or gradual, not radical or destructive, as with organised ferments. Within certain limits of temperature, and in the presence of water, which is absolutely essential to the action, the diastase is capable of converting dissolved starch into dextrin and maltose, the proportional composition of which may be varied, as we have seen, by the heat at which the malt has been dried, and by the temperature of the mashing liquor.

Now if the work of the maltster has been properly performed, diastase should be present in active quantity, and the starch cells should be so modified by the process to which the grain has been subjected that, when the malt is infused, the whole of the available starch should be converted within a short and fairly constant space of time. It will be apparent that if complete saccharification of starch takes place with one malt after the lapse of thirteen minutes, and with another, treated under identical conditions, only at the end of an hour and a half, it is hopeless to expect uniformity of product or regularity of working. Yet these are figures which have actually come under my experience, in a case in which an explanation was required of irregularity of fermentation and instability of resulting beer.

In ordinary circumstances far more diastase is formed in a malt than is theoretically required to effect the conversion of its contained starch; but when, as so often happens, the excess is utilised in the conversion of added starch products, such as rice or maize, it follows that it should be present in quantity sufficient to effect the purpose for which it is then employed, and it needs but slight reflection to admit the importance of maintaining the constancy of its amount. We know little enough about the action and composition of diastase, more especially in its relation to the other nitrogenous bodies found in wort; but of this we may be sure, that if in a malt yielding excellent results it exerts a converting power represented by 100, and in another malt, brewed with the same plant and under identical conditions, it only possesses a converting power represented by 8, it is not fairly to be expected that the beers yielded by the two malts will be uniform in quality, or that, under such conditions, the yeast will maintain its vigour and regularity of growth. Yet these, again, are figures which have come within my own practical experience.

It is remarkable how much information an experienced brewer or maltster can gain by critically examining a sample of malt and then biting a few of the corns. But he cannot form much of an opinion as to its conversion into brewing sugars, either in respect of time or of its diastasic power; neither can he predict with much prospect of success whether the malt will produce a stable or a fretting beer. Yet these are factors of too great importance to be ignored by those who wish to brew a wort of constant composition, and a beer of uniform flavour and keeping properties.

If we turn for assistance to the chemical analysis of malt, the information afforded is lamentably inadequate. Indeed, as generally carried out in this country, the analytical figures have scarcely the practical value of the paper upon which they are written. I am conscious that in making this statement I am charging myself with inconsistency, because I have made many analyses such as those I now condemn; but I may perhaps be allowed to state in extenuation that, since I formed the views I now hold, I have always added to such analyses determinations to which I shall presently allude, and which in a great measure, if not fully, compensate for the valueless nature of the other figures.

The determinations usually made are as follows:—Maltose, dextrin, soluble nitrogen calculated as albumenoids, acidity in terms of lactic acid, ash, total dry extract, moisture, dry grains, and brewers' extract per quarter. Let us now subject these estimations to a critical examination.

A brewer who looks at a malt and then bites it, should be able to say without hesitation whether it is high or low kiln dried. With a knowledge of, and due reference to, Graham's experiments, he will then be able to tell whether the ratio of maltose to dextrin is above or below the normal amount. An experienced man will, moreover, make the estimation far faster than a chemist could possibly hope to do, and unless the latter analysis be most exhaustive and be performed with the aid of a polariscope, which is absolutely essential if accuracy be required, the former will be for practical purposes as reliable as the chemist's figures. We have not yet a sufficiently intimate acquaintance with the compounds intermediate between maltose and dextrin formed in mashing to enable a brewer to derive any reliable information from an inspection of figures in which the maltose or dextrin vary with respect to one another only to the extent of one or two per cent., and this being the case, I am unable to perceive the value of such repeated estimations; always premising that the brewer is sufficiently intimate with the investigations of Graham, O'Sullivan, and Brown and Heron, to which I have referred. If on the other hand he is not acquainted with them, he will be totally unable to appreciate the meaning of the maltose and dextrin values actually presented to him as the result of malt analysis.

The determination of total soluble nitrogen as albumenoids is untrue upon the face of it, because it expresses the nitrogen due to the important class of bodies known as amides in terms of albumenoids or proteids, when as a matter of fact they do not belong to the group at all. Nevertheless, they exist in malt-wort to a very considerable extent, and do indeed exert a far more favourable influence upon the nutrition of yeast than several groups of proteids, with which they are erroneously included. In ordinary circumstances a malt might be condemned as unfit for the production of stable beer because it gave a high record of nitrogen when calculated into proteids; whereas it might well be that the proteids were low and the amides were high in amount. In such a case the conclusion would not only be worthless, but actually misleading. If the nitrogen estimations be made, after the system of Ullick, in terms of amide, albumenoids, peptones, and nitrogenous combinations of an unknown character, then the figures possess a real value which would be increased if these were collated with the practical results obtained by using the malt which had yielded them. But the process is very tedious and complicated, and it is not a matter of surprise that it is not more generally used.

A maltster has only to bite a sample of malt, and he will at once know whether or no it is "slack." That is, he will be able to tell without the chemist's assistance if it contain an undue amount of moisture. In such a case he would expect to find a high proportion of acidity, because it is well known that the presence of moisture is favourable to its formation. There is, however, very little ground for believing that the total acidity in malt is due exclusively to lactic acid, because of the difficulty of estimating the other acids to which it should possibly be referred. The estimation has, therefore, but little to recommend it.

The ash in malt scarcely ever varies more than a few tenths one way or the other, from 2 per cent.; a knowledge of this fact obviates the necessity for continuous determination.

The extract of malt, as determined in the laboratory, is nearly always erroneous, because of the difficulty of obtaining an accurate record, on the small scale, of the number of pounds of malt that will, in practice, be found to constitute a bushel. This will, as brewers and maltsters well know, vary with the method of loading, and I have found that these results, when obtained in actual practice, scarcely ever accord with those yielded at the hands of the most competent analysts in the laboratory.

The net result, then, of all these determinations, is that they convey very little, if any, new or useful information to the brewer. There are, however, many points in connection with malt and its making, upon which information should be forthcoming, because they are of vital importance in connection with malt considered as a yeast food. The brewer is seldom able to tell by his own or by a chemical examination of malt whether the barley has been subjected to insufficient or excessive steep; whether the sprinkling on the floors has been properly managed; whether the water has been added in too great quantities at a time, or at the wrong period of growth; whether the malt has been loaded too early upon the kiln, or whether the heat has

been applied too strongly at the early stages of kiln drying and before the moisture has been expelled. In the latter case the diastasic power would be greatly reduced, in addition to the formation of a vitreous film upon the surface directly next to the husk, which would protect the interior from the due action of the heat, and would produce an imperfect malt, generally unsound, and incapable of saccharifying completely within the limits of time normal to a well-made malt.

These products of carelessness can be controlled, at least provisionally, as I have found after many practical experiments, by the three following determinations :—

1. The stability of the wort obtained from infusion of the malt when "forced" at a high temperature in sterilised flasks.

2. The time required for complete saccharification.

3. The diastasic power as compared with that of a standard malt calculated as equal to 100.

There is room for considerable variation in the manner in which these determinations may be made. I find, however, that the results are of great value when conducted as follows :—

Stability.—Ten grammes of the malt, which should have been sampled in a carefully cleaned tin, are mashed with 100 cc. of recently boiled water at a temperature of 158° F. for two hours. The wort is then filtered into a small sterilised flask. The latter is previously heated for several hours in a hot-air oven at about 300° F., and the filter paper and funnel are likewise sterilised at the same temperature. The neck of the flask is plugged whilst still in the hot oven with sterilised cotton wool, and the funnel inserted through the wool. The whole apparatus is then covered with a bell jar, so that the possibility of the advent of fortuitous germs is well guarded against. When the filtration is complete, the funnel is carefully withdrawn without disturbing the cotton wool, and the flask containing the wort is removed to an incubator at a constant temperature of about 85° F. The contents of the flask are placed under observation, and their condition noted every twenty-four hours. If at the end of forty-eight hours the worts are bright, and exhibit no "mothering," I consider that they have satisfactorily withstood this important test. A well-made malt will always do this, a badly-made malt never, unless it has been so imperfectedly malted as to be nearer raw grain than malt, in which case it is obvious that it will not offer so favourable a nidus for fungal nutriment as would a malt, but in this event its defects would be detected by the experiments which follow. It is unnecessary to dwell further upon the importance of mashing with a malt free from foreign and objectionable organisms, and it will be found that the method of examination as above explained is an easy method of attaining this desirable end.

Time of Saccharification.—Ten grammes of coarsely ground malt are introduced into a small beaker, and 100 cc. of water at 158° F. are added and well stirred in with the malt. The beaker is immediately placed in a water bath, also maintained at a temperature of 158° F. In these conditions the mash, which is frequently stirred, is periodically tested with iodine solution, the time from the commencement of the mashing until no starch reaction is obtained being carefully noted.

Diastasic Power.—Twenty-five grammes of coarsely-ground malt are digested for about three hours with cold water; the amount of water is made up to exactly a litre. It is occasionally shaken. At the end of the three hours the solution is filtered off bright. Three grammes of pure starch, preferably in the form known as "soluble" starch, are next mixed with 500 cc. of water, and heated to 180° F., with constant stirring. This starch solution is then made up to one litre. 100 cc. of the starch solution are placed in a flask and heated to 140° F., and 25 cc. of the bright aqueous malt extract are then added, the whole being kept at the temperature of 140° F. for 20 minutes. The solution is then raised to the boil for a moment only, so as to stop further conversion. 50 cc. of the solution are now taken, and the copper oxide reducing power gravimetrically determined. This is compared with that of a fair standard malt similarly treated, the latter being taken as equal to 100.

It will be seen that the above estimations are simple, and are capable of being rapidly performed. I do not for one moment claim originality for them, but I do not hesitate to advocate their adoption. Each brewer should, in my opinion, fix his own standard, and demand that his malt should be delivered up to it. I have, for instance, found it advisable to fix the following limits for stock or pale ale malt. It should take between 20 and 30 minutes to completely saccharify. It should have a diastasic power not lower than 90. The "forced" wort should remain bright at the end of 48 hours, and should not then have developed any "mothering."

The judgment of the malt should be formed, in conjunction with the ordinary methods of testing, upon these three determinations taken together. The maltster may grumble at first at having to fulfil such requirements, but when he finds that it is insisted upon he will, by due attention to the various stages of malting, be enabled to meet them, and deliver malt constant and uniform in properties. This done, I feel assured that one of the chief causes of irregularity of fermentation and bad beer production will have disappeared; and I have therefore no hesitation in recommending this method as a valuable auxiliary to the general examination of malt as now performed by the brewer.

It is desirable, before proceeding to discuss the method of producing pure yeast in the brewery, that we should dwell briefly, at any rate, upon the means whereby two essentials of a good brewery wort may be attained, the one efficient aëration, the other sufficiently prolonged cooling without exposure to conditions which invite contamination by organisms which may be and generally are present in the air of cooler rooms.

Granting the necessity of aëration, it is obvious that it can only be secured under the conditions at present obtaining in this country by protracted exposure, and by the use of very shallow coolers. If the depth of beer were great the aëration would only take place, with any approach to thoroughness, upon the surface of the wort, whilst cooling in such circumstances would be prolonged until it were impracticable. It is this very exposure to the influences of non-sterile atmosphere which constitutes a source of danger in the production of beer. Especially is this the case in the neighbourhood of large towns, where the air is admittedly impure. Exposure of wort in this way at temperatures best adapted to germ multiplication before the yeast has been introduced constitutes without doubt a blot upon our system of beer preparation.

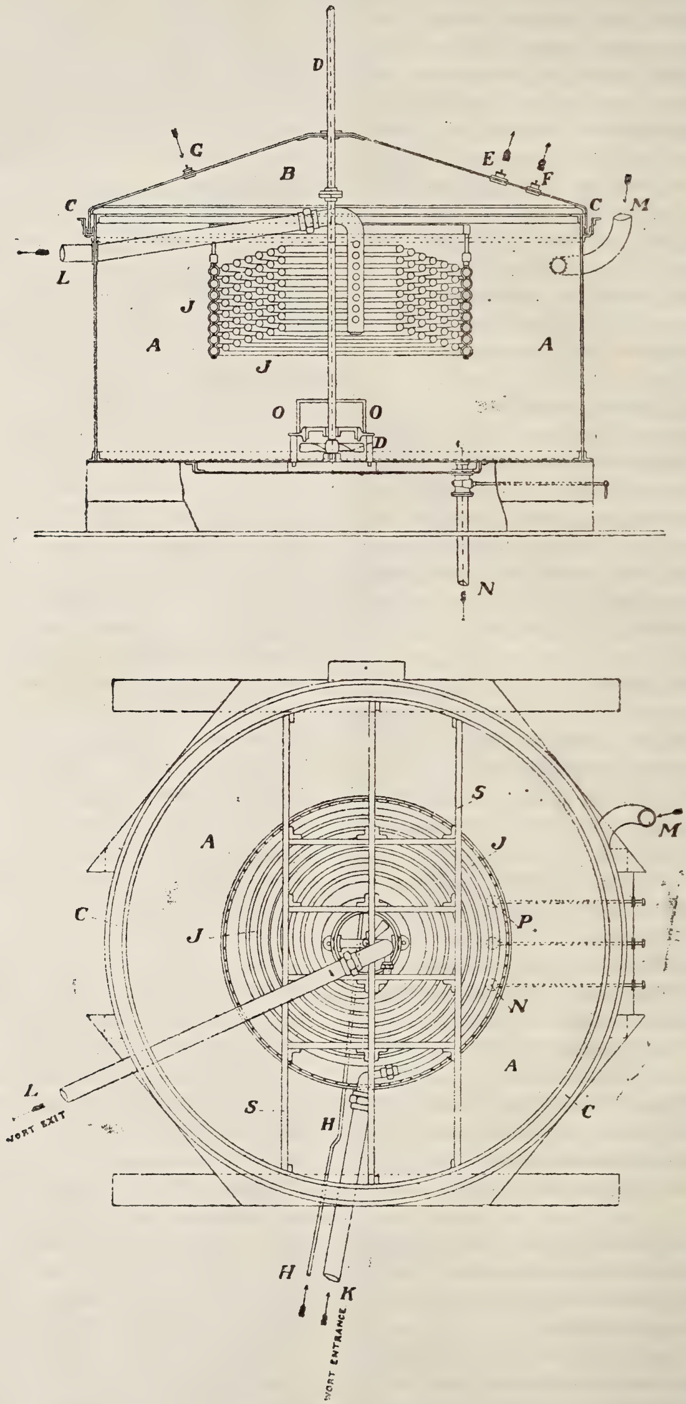
How best to obviate the defect is a question which requires most careful attention. Pasteur went so far as to devise an apparatus destined to accomplish the object, and it is within the knowledge of many of you that it has been erected and worked in English breweries. It will be freely admitted that it was theoretically sound, and should, *prima facie*, have yielded good results in practice. Indeed, it was doubtless such considerations that induced the proprietors of some of our breweries to sanction its adoption. It was, however, unsuccessful in practice. To discuss the reasons of its failure would detain us too long; it may suffice, therefore, to say that the views of the illustrious inventor did not receive complete application in the apparatus in question, and the flavour of the beer which passed through it was not such as to commend it to our brewers.

This failure should not, in my opinion, prejudice us against another apparatus constructed with a similar object in view, by Velten, of Marseilles. I am not aware of its having been erected in England, but I have seen it working on the large scale in some of the best breweries on the Continent, and have heard none but satisfactory accounts concerning it. Its action is rendered easily intelligible by reference to the illustration on page 1102.

It will be seen to consist essentially of an air-tight vessel, preferably of copper, in the centre of which is fitted a powerful refrigerating apparatus, through the tubes of which water of any desired temperature can be passed. A shaft piercing the cooler vertically terminates in a screw which can be actuated by machinery from without. The vessel is well sterilised by steam, after being cleaned and closed down, prior to the introduction of the wort. The latter is admitted by the pipe, M, which is suitably controlled by a cock. Its exit when cooled takes place through the pipe, N, whence it passes direct to the fermenting tuns. When the cooler is filled with wort, the screw is caused to rotate, the sterilised air admitted by the pipe, H, and the cold water passed through the coil. This is continued until the desired pitching temperature is attained, when the screw is stopped, together with the flow of cold water, and the wort allowed to rest in order to deposit suspended and precipitated solid matter. I should not be justified in the assertion that this apparatus would be found to answer in English breweries, because I have not seen it applied to the high fermentation system; but I can see no reason why it should not be successful, and in this case the saving in respect of space would obviously be very great. The wort remains in this vessel in all about three hours.

We are now in a position to approach the question of pure yeast culture from an essentially scientific standpoint, which will be materially strengthened if we admit that fluctuations in flavour and quality of English beer are in the main attributable to the fact that we seldom, if ever, work upon the commercial

FIG. 30.



VELTEN'S COOLER (HOLM).

A, the wort vessel; B, removable cover; C, water packing; D, axis terminating in screw, usual rotation 130 revolutions per minute; E, F, steam exits; G, opening for introduction of sterilised air after the cooling of the wort; H, pipe fitted under the screw for the introduction of sterilise air during the cooling of the wort; J, spiral refrigerating system; K, I, water entrance and exit of same; M, wort entrance: N, wort exit; O, manhole.

scale with pure yeast. We have been in the habit of attempting to explain any observed defects by reference to various ingenious theories. Their value is not capable of better estimation than that of Hansen, who thus expresses his views upon the subject:—"Much has been said and written about the degeneration of yeast in breweries. The foreign journals periodically give prominence to signed articles upon the subject, penned by the most eminent specialists. This degeneration is attributed to the influence of malt, of water, and of other factors. But upon a critical examination of the arguments presented in support of these hypotheses they are seen to resolve themselves into vague and obscure assumptions, which are not supported by any accurate experimental investigation whatever. What is the nature of this degeneration? How do we know that *S. cerevisiæ* can degenerate? The reply is simple—At present we have not determined what *S. cerevisiæ* is." It is but necessary duly to reflect upon the truth of these pregnant words in order to follow with greater interest the exposition which now follows of the method devised by Hansen, of cultivating an undoubtedly pure crop of pitching yeast from a single and isolated cell.

The preliminary operations have to be undertaken in the laboratory, and before the cultivation can be commenced a few preparations are necessary. Some hopped and boiled wort thoroughly sterilised and free from suspended flocculent and precipitated matter, and having a gravity of about 13 or 14 per cent. Balling, is mixed with about 5 per cent. of pure gelatine. The latter is then melted, thoroughly mixed with the hopped wort, and sterilised. The gelatinised wort is next introduced, with all precautions against contamination, in quantity of about 10 cc. into small sterilised assay flasks. These are kept covered with sterilised paper in a germ-free chamber, and are used as and when required. If they develop colonies of germs, or other visible growth, they are at once rejected. A series of sterilised Chamberland flasks are partially filled with sterilised distilled water. One or more of these may be required for use during the progress of the operations. A sample of yeast from which it is desired to produce the pure culture is placed in a small beaker, or flask, and well mixed with a sterilised glass rod. One of the Chamberland flasks containing the sterilised water is opened, and a few drops of the yeast deftly and rapidly introduced. The flask is then closed with all possible speed, and the yeast and water intermingled by agitation. One drop of the mixture is next placed upon a slide for examination under the microscope. The object thus far is to secure a sufficient but not too great a dilution of yeast, and it is in order to test this that the drop, extracted with a sterilised rod, is submitted to microscopic examination. It is considered satisfactory if 50 or 60, and not more, cells are discernible in a single field.

Fig. 31.

The Chamberland Flask.

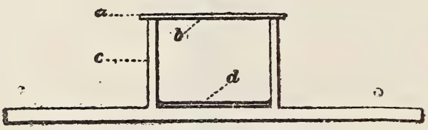
The small terminal tube is plugged with cotton-wool or asbestos.

The gelatine wort in the assay flask is next gently melted over a low-burning Bunsen flame, and when quite liquid the flask is plunged into a water-bath maintained at a temperature of about 86° F., and never under any circumstances allowed to exceed 95° F., all windows being carefully closed, and every possible precaution being taken to render the access of fortuitous organisms a matter of impossibility. A piece of stout platinum wire about an inch long is held in sterilised forceps in a Bunsen flame till it glows red; it is then placed under a sterilised cover. When cold, it is again seized by the sterilised forceps, and dipped into the Chamberland flask, the contents of which are agitated previous to the opening of the flask. The wire, having taken up a drop of the yeast in the water from the flask, is quickly withdrawn and dropped into the flask on the water-bath containing the gelatine wort. The vessel containing the latter is now taken out of the water-bath, and well shaken in such a way as to avoid frothing.

A moisture cell is next employed. It is previously thoroughly cleansed and sterilised, and, to make assurance doubly sure,

the cover-glass is washed with a weak solution of alcohol in sterilised water. A glass spatula, previously sterilised in the flame, is dipped in the gelatine wort containing the yeast introduced by means of the platinum wire, and when sufficient of the mixture is adherent to the spatula, the latter is taken out, and by its means a film of the gelatine wort is spread as an even coating over one surface of the cover-glass. Three or more cover-glasses may be similarly treated, and when the wort is evenly spread, they are placed under sterilised covers and allowed to stand until by the agency of the added gelatine solidification is effected. A few drops of sterilised water are now placed in a sterilised moisture

FIG. 32.



MOISTURE CELL (HANSEN).

(*a*) Cover-glass. (*b*) Film of gelatine wort. (*c*) Small glass cylinder. (*d*) Few drops of water. The whole apparatus is conveniently placed under the microscope.

vessel. The top edges are lightly rubbed with vaseline, and the cover-glasses then pressed on to the top of the vaselined chamber in such a way that the film of wort is enclosed within the vessel, and is, by means of the vaseline coating, secured from communication of any kind whatever from without.

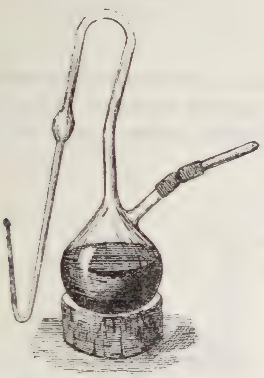
So far, the process consists in entrapping a few isolated single yeast cells in the gelatine wort, and one great difficulty in connection with the work, and one which can only be overcome with much practice, has next to be encountered. This is neither more nor less than the task of finding the cells which have been thus entrapped, and recording their position on the cover-glass. To this end the moisture chamber is placed under the microscope, and the cover-glass subjected to a searching examination with a quarter objective. Not more than one cell should be noticeable in each field, otherwise the particular cover-glass should be discarded for the experiment. The cell having thus been isolated its position on the cover-glass is to be located. This is effected by means of a "cell marker" (sold by Klönne and Müller, Berlin). It is affixed by a screw to the microscope in place of the removed power, and slowly lowered down upon the cover-glass. It is scarcely necessary to state that this should not in any way be moved. The marker leaves a black ring of ink upon the outer surface of the cover-glass, and it is within this very small area that the entrapped cell is situated. A recognisable mark or number is then affixed in ink to the ring. The position of several cells on one cover-glass may thus be recorded. They are identifiable by reference to a sketch plan taken at the time of the marking, upon which the number or mark attached to each cell is written, together with a sketch of the contour and size of the particular cell under notice, and a record of its position in the microscopic field. It may here be conveniently noted that immediately after use the spatula, vessels, forceps, platinum wire, cover-glasses, &c., are plunged into a ten per cent. solution of sulphuric acid, this being an essential precaution.

The moisture chambers, thus treated, are placed in an incubator maintained at a constant temperature of 77° F., and are left undisturbed for twenty-four hours. They are then removed and placed under the microscope. This time there is no difficulty in finding the respective cells by reference to the sketch diagram, and it is only necessary to use a low power, say one quarter. It will be found that each cell has developed into a minute colony, of which there should be but one within each ink ring. In order to be confident that the colony is derived from the single cell, it should be perfectly round. The presence of a stray cell, previously unnoticed, would assuredly spoil the circular appearance of the colony. An inspection of the various fields at this stage in the growth must carry conviction that no two colonies are sufficiently close to allow of coalesence on enlargement within the period allowed for further incubation. This examination serves to confirm the accuracy of the previous day's work, and any colonies not falling within the prescribed conditions would be immediately discarded and not further watched.

The moisture chambers, after having been thus examined, are returned to the incubator, and left untouched for a further period of forty-eight hours. They are then again examined under the microscope, in order to trace the development of the colonies, and to guard against coalesence. The colonies are now, however, visible with the naked eye. Indeed, they resemble the well-known colonies obtained by the germ analysis of water by Koch's method. The position of each colony

is now marked by covering it in white paint on the outside of the cover-glass. The particular cell which has developed this colony is further recorded by reference to the original marking of the sketch diagram. When the paint is dry, the cover-glass is carefully removed from the moisture chamber and placed within a sterilised cover. A Pasteur flask containing pure hopped sterilised cold wort is heated with a flame at the end

FIG. 33.



HANSEN'S MODIFICATION OF PASTEUR'S FLASK.

Flasks of various capacities are employed during the process of cultivation.

from which the asbestos protrudes. Whilst thus being heated the rubber at the other bend is warmed so as to allow of its easy release. It is quickly removed, and a colony, marked on the outside of the glass with paint, is dexterously pricked with a platinum needle previously sterilised. The rubber stopper of the Pasteur flask is then quickly removed, and the needle, containing some yeast cells derived from the marked colony, plunged into the flask. The rubber is then replaced, the flame removed from the asbestos, the contents of the flask well shaken, and the inoculation of the wort with yeast derived absolutely from one single cell is complete. The flask is now transferred to an incubator kept at the same temperature as before. The growth of the yeast is speedy; after the lapse of 48 hours a goodly crop of yeast will have developed. With every precaution against contamination the beer is then removed from the flask. Sterilised wort is caused to take its place, and it is again returned to the incubator for a further period of 24-48 hours. At the end of this time the crop has become considerable, and it is moreover in a rigorously thriving condition. If now the quality of the yeast is known, and it is not desired to subject it to an analytical examination for ascospores, it may be cultivated in the manner already indicated by changing the beer for wort from time to time, until sufficient is accumulated wherewith to charge the apparatus shortly to be described.

Should it be required to transport the samples of pure yeast thus obtained, Hansen has found that they may safely be sent through the post if wrapped in a double layer of blotting paper previously sterilised. Of course the introduction of the yeast into the blotting paper must be effected in a germ-free atmosphere, otherwise the risk of contamination is obvious. Of course, only small samples, intended for further growth, could be thus despatched. In order to keep such cultures for years, so as to have the source of a pure stock to hand, it is advisable to introduce a very minute quantity into a sterilised Pasteur flask containing a ten per cent. solution of sterilised cane sugar. The fact that yeast may be thus preserved constitutes a very extraordinary problem in physiology, and has not, so far as I am aware, received a satisfactory explanation. The cultures may be preserved for some months if similarly introduced into Pasteur flasks containing sterilised wort.

If, however, it is desired to test the purity of the sample, it must be further subjected to the following treatment. Plaster of Paris is rubbed with water into a thick paste, then pressed into pyramidal blocks, the basal circumference of which has a diameter of about two inches. The cone is about two inches in height, and has a flat, smooth surface at the top about an inch in diameter. Once this has well set it is dried and sterilised for a long time at a high temperature. Thus prepared, it is placed in a flat glass dish, which is filled to the depth of about a quarter of an inch with sterilised water. It is then loosely covered with a sterilised cover-vessel, in such a way that the advent of air is secured. This constitutes the apparatus required for ascospore formation. After the second addition of wort into the culture flask, and its growth, as above described, the beer is run off from the flask and a sterilised glass scalpel mixed in with the yeast. With this a layer of yeast about the size of a sixpence is smeared on to the top surface of the plaster of Paris. The top of the cover may conveniently hold four or five such flecks. The block is then covered as above described, and placed in an incubator to await the formation of ascospores, for which it is examined from time to time by removing a portion from the flecks on the cone, and

rubbing into a drop of water placed on a glass slide, which is then looked at under a microscope in the usual way. The rapidity of their formation will, as already pointed out, depend altogether upon the temperature of the incubator in which the block is placed, and the particular species or variety of saccharomyces experimented with. Its identity can be established by recording its deportment under these conditions, and by subsequent reference to Hansen's Tables, given on pages 1069-70.

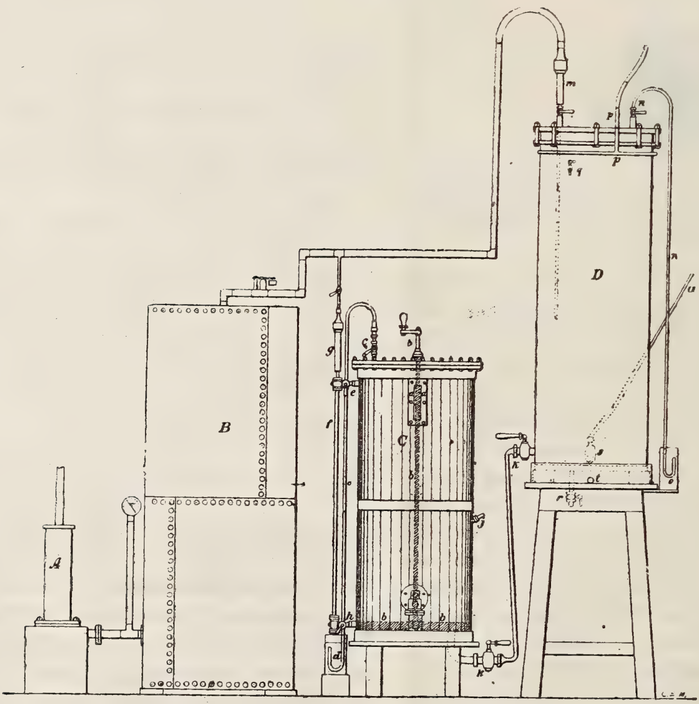
The purity of the sample having thus been placed beyond doubt, it is next grown in increasing bulk, with removal of the beer formed, and renewal of sterilised wort until it is removed to a flask similar to that shown in Fig. 34.

FIG. 34.

TRANSFER CULTURE FLASK (HANSEN).

From this it is removed to the yeast apparatus shown in general elevation in Fig. 35, and in more detailed treatment in Fig. 36 (p. 1107).

FIG. 35.

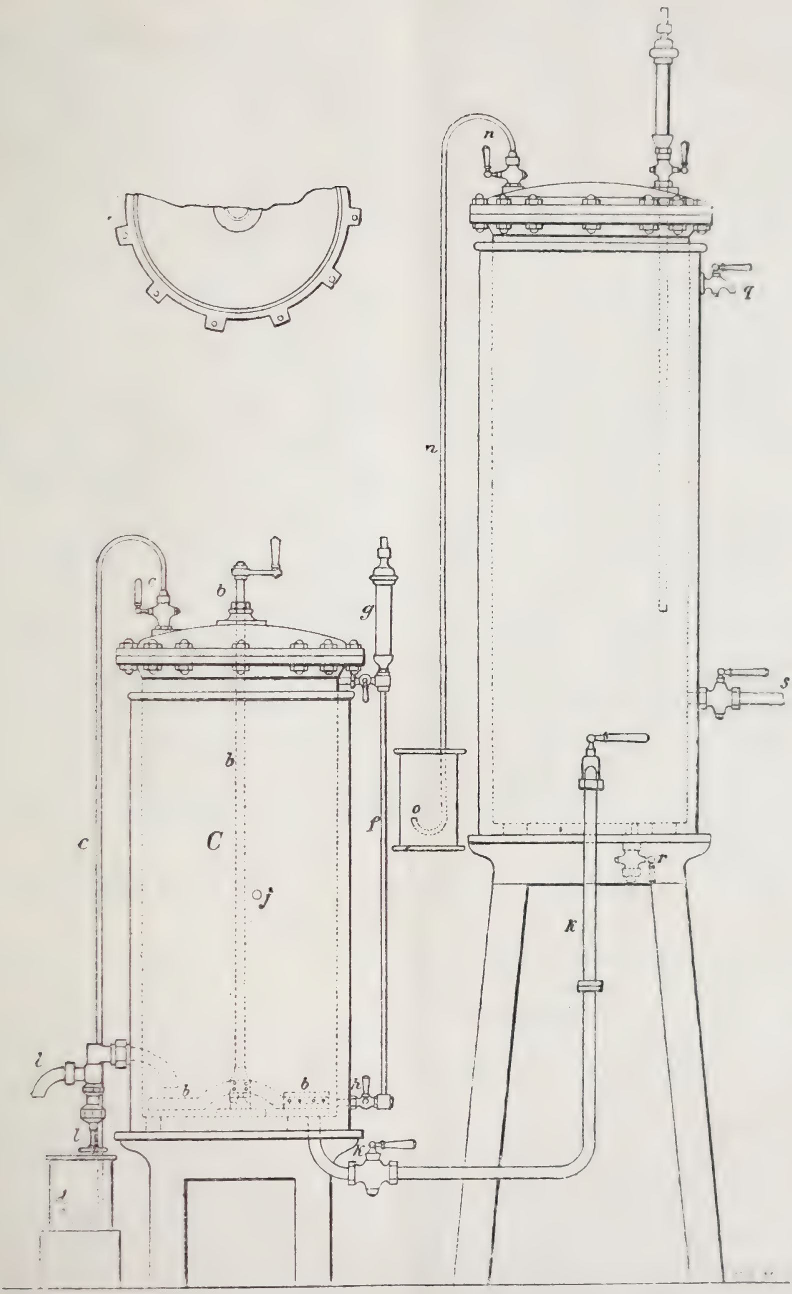


HANSEN AND KÜHLE'S YEAST APPARATUS.

The apparatus is so simple in construction and in principle, as to need but little explanation in addition to the illustrations. As Hansen says, it is an enlarged form of Pasteur flask with two necks. A is an air pump, actuated by machinery, and capable of supplying air, compressed to about 1-4 atmospheres, to the reservoir, B. C is the miniature fermenting tun, and D the wort holder. The latter is thoroughly sterilised by means of superheated steam; this is displaced by means of the air obtained from the reservoir, B, and is sterilised by being drawn through the stuffing box, M, which is filled with cotton wool. Boiling hopped wort is introduced through the pipe, S, to which it is conveyed by the main pipe, U. This is cooled by circulating cold water through the hollow jacket, P, which lines the wort holder. The air required in the aëration of the wort is passed in

through M. The fermenting vessel, C, is sterilised in a manner similar to D; G being the air filter of cotton wool through which its sterilisation is effected. The height of the liquid is noted on the glass tube, F. The carbonic acid gas disengaged during fermenta-

FIG. 36.



tion passes through the tube, *c*, and emerges from a water trough at *d*. The yeast and wort are mixed by means of the agitator, *b*. The yeast is introduced, and samples are taken by means of the small tube at J. When installed, the fermenting vessel is cased in wood. Fig. 36 shows this casing removed. Once the yeast has been added, the yeast may work for a year, or longer if desired, because some residual yeast is always left in the apparatus in order to ferment the fresh wort introduced. In working the apparatus, Hansen insists upon two points being kept in view. There must be a sufficiency of steam to effect a true sterilisation, and during the withdrawal of yeast there should always be a good pressure of sterilised air. It is obvious that the apparatus may be of any convenient size, and may be adapted to the growth of any desired quantity of absolutely pure yeast.

From it the pure yeast is drawn as required. It must not be imagined that this process is any longer in the experimental stage. It has been worked for some long time now in several breweries, with the most brilliant results. In those establishments "returns" are unknown; beer can be bottled without leaving a sediment; special flavours can be secured and maintained; and the brewing operations are carried on with a regularity to which climatic change presents no obstacle. This, in itself, is sufficient to constitute the name of Hansen even equal in importance to that of Pasteur in the history of fermentation. Those who have studied the subject well know how great must be the merit of Hansen's work to have earned, as he has fairly done, in the eyes of European physiologists and chemists, so great and so coveted a distinction.

I have ventured to think that it would not be unworthy of the traditions of the Cantor bequest to place such contributions to industrial science before the brewers of this country, partly in the hope of stimulating them to activity in technological research, partly with the idea of bringing before them, and of recording in the *Journal* of this Society, the researches and their applications, to which it has been my pleasing duty to direct attention. If I should not altogether have succeeded in these endeavours, I trust I may at least have been enabled to demonstrate that the morphological and physiological study of yeast are at once of deep philosophic interest and of the greatest commercial importance.

Miscellaneous.

PARIS EXHIBITION, 1889.

The following letters of the Lord Mayor, Chairman of the British Section, and Sir Frederick Leighton, President of the Royal Academy, on the formation of a Fine Art Section, have been published:—

Sir,—I shall be glad to call your attention to the subjoined letter which has been addressed to me by Sir Frederick Leighton on the subject of a British Fine Art Section at the forthcoming Paris Exhibition. The patriotic sentiments so eloquently expressed by the President of the Royal Academy, speak for themselves. In the name of the Executive Council of the British Section, over whom I preside, I venture to entertain the hope that those sentiments will be shared by many who will be both able and willing to give practical help in securing a due representation of British art at Paris next year.

The Council have not felt justified in applying to the formation of an art section any of the funds received from Industrial Exhibitors, but they have been able, from another source at their disposal, to promise a contribution of £500 to that purpose, conditionally on the balance being subscribed by the public. From inquiries I find that a sum of about £3,000 will be required to defray the incidental expenses of an art section, such as freight, insurance, packing, &c., and as Sir Frederick Leighton has given emphasis to his letter by a donation of £100, only about £2,400 remains to be collected before such an undertaking can be practically carried into effect. I feel certain that the public will make up this amount, and that private collectors and artists will then be willing to lend their works of art for the representation of Great Britain at Paris next year. I may add that the authorities of the Exhibition undertake the cost of arrangement and care during the period of the Exhibition.

I am, Sir, your obedient servant,

P. De Keyser, Lord Mayor.

Mansion-house, London,
October 1st.

Copy of Letter from Sir Frederick Leighton, Bart., P.R.A.

My dear Lord Mayor,—The decision, final as I understand, of the French Government, to bear no part in the expense of a British Fine Art Section at the forthcoming International Exhibition in Paris, is one that I, in common with those who have a care for English Art, cannot but deeply deplore. I had clung to the hope that the large liberality displayed under similar circumstances in Antwerp, in Berlin, in Munich, would on this occasion be emulated in that foremost centre of artistic life, Paris. That this hope, in which I did not stand alone, has been disappointed, is the more to be regretted because,

unless private liberality can be enlisted to supply the funds for which we must not hope at the hands of the Government of either country, we alone shall remain unrepresented at this great display of the contemporary artistic achievements of Europe; and this, too, at a time when the great qualities of our school, its sincerity, its healthiness, its versatility, have succeeded, precisely through the agency of international exhibitions, in winning a large degree of sympathetic appreciation in places where not many years ago it was almost wholly unknown.

The difficulties which stand in our way have been represented by you, my Lord Mayor, and have, indeed, been strongly urged by myself on our friends across the water. You have reminded them that, in the absence of a Royal Commission and Government aid on our side, no fund exists here wherewith to defray the costs which attend such an Exhibition—freight, packing, insurance, offices, and staff; you have pointed out, I believe, that works such as would alone be worthy of the occasion are, with rare exceptions, not in the studios of the artists who produced them, but in the galleries of private collectors; and that though jealousy for the honour of British art would, we cannot doubt, prompt a number of these fortunate men to lend, once again, from their treasures, they cannot well—they cannot with decency—be asked to take upon themselves considerable expense, in addition to the temporary loss of possessions they value so highly. Meanwhile, I find it difficult to resign myself wholly to the humiliating absence of the handiwork of English artists in this Exhibition, to which lovers of art will flock from every part of the civilised world; and, I ask, must England alone stand aside in this noble competition? I take the course of addressing this question to your Lordship, not merely because I know you to be personally warm in the interest of art, and fertile in initiative, but also because Englishmen are wont to turn to the holder of your very important office, when it is desirable to call into existence a fund for a great object of public good. Can, then, any such fund—not necessarily a very large one, but such a fund as would save our credit in the present deplorable dilemma—be raised by an appeal emanating from you, who, as President of the British Section of the Paris Exhibition, could speak in this matter with twofold authority and weight?

I, at least, as one on whom his office lays the duty of speaking from time to time in the name of British artists, could not rest satisfied were I to omit any step that seemed to offer possibilities of success in such a matter and at such a moment.

I therefore lay this suggestion before your Lordship, and I do so with full confidence in your sympathy, and will only add that should you see your way to giving it effect, I should on my side, of course, ask your permission to contribute my mite in the shape of a cheque to so excellent an object.

Believe me, my Lord Mayor, faithfully yours,
(Signed) FREDERICK LEIGHTON.

CANES AND STICKS USED IN THE MANUFACTURE OF WALKING STICKS, UMBRELLA HANDLES, &c.

By J. R. JACKSON, A.L.S.

(Continued from p. 1038.)

PART II.

In enumerating the materials used in the manufacture of walking sticks it has been thought best to classify them in alphabetical order according to their commercial names. Though the following is a fairly complete list, and represents most of those exhibited in the Kew Museum, it is by no means an exhaustive list, additions being frequently made.

Acacia.—The name of this stick designates its peculiar colouring rather than its botanical origin, and any stick that is sufficiently strong, and lends itself readily to artificial colouring, is used, such as the crab, dogwood, &c.; the specimens at Kew are the produce of a hard-wooded shrub or small tree, found in the forests of Mid and Southern Europe, probably belonging to the dogwood order. The sticks, in their prepared form, have found much favour for ladies' umbrella and sunshade handles. They are made in various shapes, but the colour is generally blueish or greyish, with a metallic lustre, and occasional dark streaks.

Apse or *Asp.*—This is the wood of the aspen (*Populus tremula*); it is very light, both in colour and weight, and has little else, perhaps, to recommend it for walking sticks. The supply is obtained from our own country.

Ash (*Fraxinus excelsior*).—This tree furnishes a variety of sticks, known in trade under different names, as, for instance, the root ash, which consists of the saplings with the roots attached, which form the handle; then there is the cross-head, in which the roots, instead of forming a somewhat globular knob, take a twist at right angles from the stem. These, as has been before stated, have been grown, and so directed during their growth, on a large scale in Surrey during the last two or three years. The figured ash is another form, in which the bark has been scarified into various designs during growth, and on healing has left a permanent marking. These latter are, perhaps, more curious than beautiful, but still they have their admirers. The ash can be treated in various ways with the bark either left on or removed. Some of those with the bark remaining, when properly cleaned, dressed, and polished, make very pretty sticks, and are not unlike those of the orange.

Bamboo.—The bamboos furnish a great variety, and a very large bulk of the material used by the walking-stick maker. They come, of course, chiefly from the East, but their botanical sources are difficult to determine. Amongst those which may be called true bamboos, namely, those furnished by the genus *Bambusa*, may be mentioned the Whampoa bamboo, probably the produce of

Bambusa metake. They are noted for their irregular jointing; they are of a clean, lemon yellow colour, and not long since were much used for sunshade handles. They are imported from China. The yellow bamboo and the black bamboo are also well known, their colours being indicated by their commercial names. These canes are imported from Japan and China, and are no doubt the produce of species of *Bambusa*, as is also probably the beetle-cane, so named from its intensely black colour and its scaly appearance near the root, which, however, makes it very pretty. This is also the product of a Chinese species. The dog-head bamboo is not a true bamboo, but is furnished by a species of *Arundinaria*, a closely-allied genus. The name dog-head has been given to this stick from the natural growth of the rhizome roughly representing the head of a dog, so that it is easily carved and converted into good representations of dogs' heads. These sticks are imported from China.

Bakow.—This is apparently the produce of a palm, but at present its origin remains unknown. The sticks are imported from Singapore.

Bay Tree or Laurier Thyn.—These sticks are apparently the produce of a species of *Eugenia*, though nothing definite is known about them. The wood is very hard and close-grained, almost white in colour, but with a cinnamon brown bark covering the irregular root, which makes good handles for umbrellas. They are imported from Algeria.

Beef Wood.—This wood is of a dull reddish colour, close and even-grained. It is apparently cut from the trunk of a large tree, perhaps that of *Ardisia coriacea*. It is imported from Cuba.

Beetle Cane.—See *Bamboo*.

Birch.—The saplings of *Betula alba*. The roots make good handles, and the supply is obtained from our own country.

Blackthorn.—This well-known hedge plant, known also as the sloe (*Prunus spinosa*), makes excellent walking sticks. There is always a demand for them, for when properly dressed and polished there is no other stick that has so dark a coloured bark. Latterly there has been a large sale for a special kind of blackthorn brought from Ireland, and known as Irish blackthorns. They are distinct from the ordinary blackthorn in being flattened instead of cylindrical.

Black Tork.—The botanical origin of this stick has not been determined. It has a dark-coloured bark, and the root forms an irregular knotted handle. The wood, which is hard and close-grained, forms a very rigid stick, revealing, when the bark is taken off, a dark brown wood with occasional light patches. It is imported from the West Indies.

Boxwood, Persian.—This is the true box (*Buxus sempervirens*), the wood of which is so well known as to need no description. The irregularity of the branches recommend it, when peeled of its bark, for walking sticks, and the sticks cut out from the solid trunk make good umbrella sticks, besides which it is often carved into various devices for ladies' sunshades. Another kind of wood, very similar in appearance to true box, but known as West Indian boxwood, is used to some extent for the same purposes. The West Indian boxwood of botanists is *Vitex umbrosa*, but this wood does not agree with that, and at present cannot be satisfactorily identified.

Briar.—This is also the produce of a West Indian tree (*Zanthoxylum Clava-Herculis*), the bark of which is tuberculated, or warted, for which reason it is valued for walking sticks. They are imported from the West Indies.

Cabbage, Jersey.—A well-known variety of the common garden cabbage (*Brassica oleracea*), the stems of which grow in the Channel Islands to a height of ten or twelve feet.

Carob or *Caroubier* (*Ceratonia Siliqua*). — A branching tree about thirty feet high, native of the Mediterranean coast. The tree is also cultivated for the sake of the pods, which are sometimes known as St. John's Bread, or Locust, and contain a quantity of saccharine pulp; they are used in Southern Europe for feeding horses, pigs, and other animals, and form one of the ingredients in the concentrated cattle foods. The knotted and irregular branches, when straightened, make excellent walking sticks. They are imported from Algeria.

Carolina Reeds.—These are slender, bamboo-like canes, the produce, apparently, of a species of *Arundinaria*. They are imported from China.

Cedar Wood.—This is the wood of the common pencil cedar (*Juniperus virginiana*). It is only occasionally used, and is too well known to need description. It is imported from North America.

(*To be continued.*)

General Notes.

Electric Omnibuses.—The General Omnibus Company in Paris, according to *Nature*, has introduced into its service the electricity supplied by the Electric Storage Company. The carriages run from the Arc de Triomphe to Courbevoie, a distance of about two miles. Each of the two fore-wheels is put into rotation by a separate dynamo, over which the driver exerts control. The velocity is somewhat greater than that obtained with horses.

Mica in Australia.—An important discovery of mica has recently been made in the northern territory of Australia, by Mr. David Lindsay, F.R.G.S. The discovery consists of two mica outcrops, one showing 30 feet in width. Sample slabs of this valuable mineral have been sent to London, and brought to the Society of Arts. These, though taken from the surface, are of large size. As the consumption of mica is rapidly increasing through its use in electric machines, and as sheets of large size are comparatively scarce and expensive, any new source of supply of the mineral is of considerable importance.

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Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Professor W. Chandler Roberts-Austen, F.R.S.

Lecture I.—Delivered March 12, 1888.

As many valuable mechanical properties are conferred upon metals by associating them with each other, it seldom happens that metals are used in a state of purity when they are intended for industrial purposes, and this fact was discovered at a very early period of metallurgical history. The word alloy originally comes, in all probability, from the Latin *ad-ligo* (alligo), "to bind to," and not, as Sir John Pettus thought, from the Teutonic *linderen*, "to lessen," suggestive as it is of the fact that a precious metal is lessened in value by the addition of a base one.

The late M. Dumas eloquently pleaded many years ago against leaving alloys in the oblivion to which modern chemists consigned them, and there still seems to be a prevalent impression that our knowledge of the phenomena which attends the union of metals is very imperfect, and that it rests upon a slender experimental basis. We are apt to forget the extent and complexity of the subject, and Mr. Lupton has opportunely directed attention to the number of alloys which await examination. He says*:—"Hatchett recommended that a systematic examination of all possible alloys of all the metals should be undertaken. He forgot to remind anyone who should attempt to follow his advice that if only one proportion of each of the 30 common metals were considered, the number of binary alloys would be 435, of ternary 4,060, and of the quaternary 27,405. If four multiples of each of the 30 metals be taken, the binary compounds are 5,655, ternary 247,660, and quaternary 1,013,985."

Nevertheless, if the properties of many alloys have yet to be investigated, the study of alloys generally has not been neglected. The modern bibliography relating to them is much more extensive than it is usually supposed to be, and the older writings are very full, and contain the results of far more accurate observation than they are credited with. In the early days of chemistry, as its history abundantly proves, alloys received much attention, and although the early chemists often failed to distinguish alloys from simple metals, or used them in unsuitable ways, they left an experimental record, the value of which is sadly unappreciated. From this record it is, incidentally, evident that the development of the art of separating metals from their ores and from each other was quickly followed by the acquisition of the knowledge that metals possess peculiar properties when re-united in certain proportions, and are thereby rendered more useful than they were in the pure state.

In early times some metals were used unalloyed, although at the present day they have no industrial application except in union with other metals. Antimony, for instance, now only employed as a constituent of certain alloys, was formerly cast and fashioned into ornaments, as is proved by the analyses of Virchow, and by a fragment of a very ancient Chaldean vase, which fragment, when examined by Berthelot, proved to be of pure antimony.* The implements and ornaments discovered by Schliemann abundantly show that the early Greeks were familiar with alloys of silver and gold, copper and tin, lead and silver, and with many others, all artificially prepared. Throughout the Middle Ages there seems to have been a belief that the action of metals on gold and silver was, on the whole, corrupting; and Biringuccio, in 1540, carefully defined such alloys as being "nothing but amicable associations of metals with each other," and he further pointed out that metals must be mixed by weight, and not at random.

I am not attempting to give the history of research connected with alloys, and I must pass from the 16th to the 18th century, in

* "Nature," Jan. 5, 1888, p. 238.

* "Ann. de Chim. et de Phys.," Sept. 1887, p. 135.

which we find four writers whose names deserve to be specially mentioned because they seem to have been the first to indicate the direction in which modern investigation has been conducted. These are Réaumur, Gellert, Musschenbroek, and Achard, who respectively studied 1st (Réaumur), molecular change produced in a metal by heat; 2nd (Gellert), the relation of fluid metals to each other considered as solvents; 3rd (Musschenbroek), the cohesion of alloys as shown by certain mechanical properties; and 4th (Achard), the electrical behaviour of metals and alloys. It is interesting to trace the connection between the older work and the new. Réaumur,* in explaining the hardening of steel by rapid cooling from an elevated temperature, comes very near the modern view that a metal may, under certain conditions, pass from one allotropic state to another, for he distinctly contemplates the possibility of molecular change produced by the expulsion by heat of "sulphurs and salts" from the molecule into insterstitial spaces between them. He speaks of "molecules and elementary parts of molecules" like a modern writer, and tries to show that when hot steel is rapidly cooled "sulphur and salts" cannot return into the molecules, but remain in the insterstitial spaces, and that therefore the physical properties of hard steel become quite different from those of soft. If it should be urged that the analogy between carburized iron and alloys is over-strained, I would point out that, in 1867, Matthiessen said, after appealing to the fact that in certain alloys the constituent metals are present in allotropic states, "I have always made a comparison between iron and steel (and alloys). This has been done to show that the carbon-iron alloys behave in an analogous manner to other alloys, which cannot be looked upon as chemical combinations."†

Gellert makes the analogy of certain alloys to solutions very clear, and in his "Metallurgic Chemistry," he gives a Table showing the relative solubilities of metals in each other, while in the observations which accompany it,‡ he says, to take one of the cases he gives as an illustration, "Since copper and silver, and copper and gold, dissolve one another very readily, the copper cannot be parted from iron by means of gold or silver," probably having in mind a reaction which enables silver to be parted from gold by the action of sulphur and iron. He further clearly shows that with regard to the solution of metals in a triple alloy, he understood the possibility of the division of a metal between two other metals acting as solvents.

The mechanical properties of alloys were, as I have said, investigated by Musschenbroek, who working in the early part of the 18th century, made some experiments on the tensile strength of metals and alloys. He writes of the "absolute cohesion by which a body resists fracture when acted upon by force drawing according to its length,"* and gives the tenacity of several metals, and the alloys, brass and pewter. He shows the importance of such work so clearly, that it is remarkable how slowly the mechanical testing of metals developed since his time.

Achard, whose researches were published in 1784, made a very extended series of experiments on multiple alloys, as well as those of simple metals. He pointed out that the relative conductivities of substances for heat and for electricity are closely related. He devised an appliance for the experimental verification of this fact, and, as he included alloys in his researches, it may fairly be claimed that he led the way for the important generalisation that alloys may be ranged in the same order as regards their power of conducting heat and electricity, which was made by Wiedemann and Franz in 1853-59.

The necessity of metals being pure when added to each other was hardly recognised until the 18th century, and Duhamel, who contributed the article on alloys to the "Encyclopédie Methodique," in 1792, appears to have been the first writer to insist on the necessity for making exact experiments upon alloys with metals which possess a high degree of purity, and on effecting their union by heat in closed vessels. He further pointed out that up to his time no chemist had taken these precautions, and it is certain that in conducting some modern experiments they have been neglected.

In the early part of the 19th century researches on alloys became more numerous; they were mainly directed to ascertaining the effect on the density of metals produced by alloying them, and to determining the effects of slow cooling on alloys with low melting

* "L'art de convertir le fer forge en acier," Paris, 1722, p. 321.

† Lecture delivered before the Chemical Society, "Chem. Soc. Journal," 1867, p. 220.

‡ English translation of his work, London, 1776, p. 186.

* "Elements of Philosophy," translated by John Colson, F.R.S., vol. i., p. 237; 1744.

points. Of such a nature was the work of Ermann in 1827, and of Rudberg (1830-1). Ermann called attention to the peculiar behaviour of alloys of lead and tin when solid. Rudberg studied anomalies in these alloys when in the liquid state.

Regnault showed that the specific heats of certain fusible alloys was greater near 100° than the mean specific heat of their constituents, and this fact appears, as Spring has shown,* to have induced Person to undertake researches on the latent heat of alloys, and on their specific heats.

Undoubtedly the greatest work on alloys of the first half of this century was that of Matthiessen, who worked on the electrical resistance of metals and alloys, and who was led to the conclusion that in many cases metals are present as allotropic modifications, that is, in totally different forms from those in which we ordinarily know them.

It is by no means easy to investigate the molecular constitution of alloys, but evidence may be gathered in the following ways:—

1. By comparing the properties of an alloy with those of its constituent metals.

2. By studying the behaviour of alloys in passing from the liquid to the solid state, and conversely in passing from the solid to the liquid.

3. By determining the physical constants of solid alloys, such as their specific gravity, specific heat, electrical resistance, electromotive force, and their mechanical properties, such as tenacity and extensibility.

First we must consider the methods of producing alloys, for the union of metals may be effected in three ways:—

1. By fusion—that is, by causing metals to unite by melting them together.

2. By compression of the powders of the constituent metals.

3. By electro-deposition.

The first method, by fusion, is of course the method ordinarily adopted. One of the metals is melted, and the other is added to it, sometimes in the fluid state but often in the solid. In the experiment now in progress we are taking a simple case, by melting tin and adding arsenic to it, the arsenic being added in small quantity; but the product—the alloy—will have very different properties from those possessed by either of the constituent metals. Its fracture closely resembles zinc, and is as different as possible from that of either tin or arsenic. Every metal has, of course, a definite melting point, but, apart from the heat initially required to melt a metal, we find that the union of metals is sometimes attended with an evolution, and sometimes with an absorption of heat.

The following metals evolve heat when they are united:—Aluminium and copper, platinum and tin, arsenic and antimony, bismuth and lead, gold and just melted tin; while, on the other hand, lead and tin when united absorb heat—that is, produce cold when their union takes place.

In the case of many metals these effects can only be demonstrated by the aid of delicate instruments. I have, however, selected a case in which the union of metals is attended with a considerable diminution of temperature; it is an experiment we owe to Mohr, and it will be shown subsequently that its explanation is a very complicated one. Take tin, lead, and bismuth in equivalent proportions, as finely divided as possible, and mix them with eight equivalents of mercury as rapidly as may be under conditions in which heat is not transmitted to the mixture from the walls of the containing vessel, and it will be found that the temperature falls from the ordinary temperature of the room + 17° C. to − 10° C., so that if a vessel containing water be placed in the mixture the water will be frozen. [The experiment was performed by mixing the finely divided metals with mercury contained in a glass flask, which became frozen tightly to a wet board on which it stood.] The experiment proves that by the union of metals, using mercury as a solvent, a freezing mixture may be produced, but at present I only want to demonstrate the fact. We shall see in the course of the next lecture that work has probably been done on the molecules of the metals, resulting in the absorption of heat, and the illustration has merely been given here as showing that the union of metals may be attended with the production of cold.

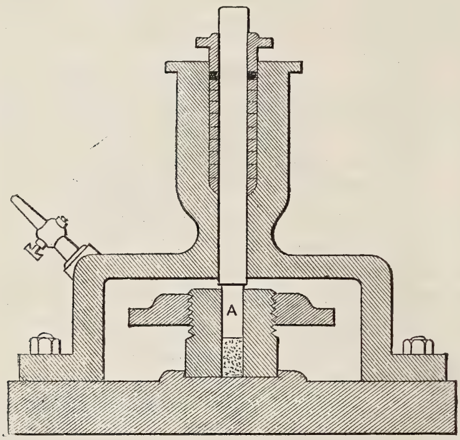
Now let me turn to the second method by which metals may be caused to unite, that is by compressing strongly the powders of the constituent metals. Since 1878, the labours of Prof. Walthère Spring, of the University of Liège, have been mainly devoted to the study of the effect of compression on various bodies.*

* "Bull. de l'Acad. Royale de Belgique," [3], t. xi., 1886.

* "Bull. de l'Acad. Royale de Belgique," [2] t. xlv., No. 6. 1878. [2] t. xlix., No. 5, 1880. See also subsequent papers in the same publication, in the "Bull. Soc. Chim.," Paris, and in the "Ber. der Deutsch Chem. Gesellschaft" (Bildung von Legirungen durch Druck), b. xv., p. 595.

The particles of a metallic powder left to itself at the ordinary atmospheric pressure will not unite, but by augmenting the points of contact in a powder, the result may be very different. His own experiments were made with the aid of a compression apparatus, the general form of the appliance employed being shown in the diagram, Fig. 1. Under a pressure of 2,000

FIG. 1.



The metallic powder is placed under a short cylinder of steel, A, in a cavity in a steel block divided vertically, held together by a collar, and placed in a chamber of gun-metal, which may be rendered vacuous. The pressure is applied to a cylindrical rod passing through the stuffing-box.

atmospheres on the piston, or 13 tons on the square inch, lead, in the form of filings, becomes compressed into a solid block, in which it is impossible to detect the slightest vestige of the original grains, while under a pressure of 5,000 atmospheres lead no longer resists the pressure, but flows as if it were liquid through all the cracks of the apparatus, and the piston of the compressor descends to the base of the cylindrical hole, driving the lead before it. The more interesting results were obtained by Spring with crystalline metals. Bismuth, as is well known, is crystalline and brittle, yet fine powder of bismuth unites under a pressure of 6,000 atmospheres into a block very similar to that obtained by fusion, having a crystalline fracture. Tin, when compressed in powder, unites, and if it is made to flow through a hole in the base of the compression apparatus, the wire so formed sometimes, though not always, emits the peculiar "cry" of tin when bent. The Table shows the amount of pressure required to unite the powders of the respective metals.

		Tons per sq. inch.
Lead	unites at	13
Tin................	,,	19
Zinc	,,	38
Antimony	,,	38
Aluminium	,,	38
Bismuth	,,	38
Copper	,,	33
Lead	flows at	33
Tin................	,,	47

We know that combinations are produced when certain bodies in solution are submitted to each others' action. But do solids combine? Is the alchemical aphorism, "That bodies do not react unless they are in solution," true? Experiment proves that such solution is not necessary. I have here two anhydrous salts—iodide of potassium—and corrosive sublimate; and these salts are at the same time dry. When they are mixed in this mortar they unite, as is shown by the vermillion-coloured iodide of mercury which is produced. But do solid metals combine in the sense, that is, in which chemical combination is possible between metals when submitted to each others action under the conditions which prevail when their powders are compressed? Mohr has pointed out* that cohesion is a form of chemical affinity, and the experiment I have already shown you of the freezing of water during amalgamation affords valuable evidence in support of his view. It occurred to M. Spring that if there be true union between the particles of a metallic powder when submitted to great pressure, it ought to be possible to build up alloys by compressing the powders of the constituent metals, and he urged that the formation of alloys by pressure would afford the most conclusive proof that there is a true union between the particles of metals in the cold when they are brought into intimate contact. Experiment proved that this reasoning is correct, for by compressing, in a finely-divided state, fifteen parts of bismuth, eight parts of lead, four parts of tin, and three parts of cadmium, an alloy is produced which fuses at 100° C. It is necessary, however, to compress the mixed powder twice, crushing and filing up the block obtained by the first compression, because the mechanical mixture of the constituent metals is not sufficiently intimate to enable a uniform alloy to be obtained by a single compression. The alloy we have produced fuses, you will observe (if you watch the projection

* Liebig's Ann. cxcvi. (1879), p. 183.

on the screen) in boiling water, actually at 98° C., although the melting point of the most fusible of its constituents, the tin, is 228° C. The formation of fusible metal by compression leads me to deal with an objection that may have occurred to many of us. It may be urged that by compressing these powders heat is evolved, and that this heat may be sufficient to produce incipient fusion of the metallic powders, or, at all events, may exert a material influence on the result obtained. This objection has been experimentally anticipated by Professor Spring. First the compression is effected with extreme slowness, and therefore there can be no question as to the sudden evolution of heat, as would be the case if the powders were compressed impact instead of by a slow squeeze; and to sum the matter up briefly, Spring calculates—taking an extreme case—that if it be granted that all the work done in compressing the powders were actually translated into heat, it would only serve to heat a cylinder of iron 10 mm. in height and 8 mm. in diameter (the dimensions of cylinder produced in his apparatus) 40·64° C.

In order that direct experimental evidence might not be wanting, Spring took the organic body phorone, a hard crystalline substance which melts at 28° C., and compressed it exactly as in the case of the metallic powders.* He took the precaution to place a shot of lead on the top of the powder before submitting it to compression. Only imperfect union of the particles of phorone resulted. The conclusion of the experiment provèd that the shot remained where it had been placed at the top of the column, and therefore the 28° necessary to melt the substance had not been evolved, for if it had the shot must have fallen through the fluid mass. I think, then, it is absolutely safe to conclude that, in the compression of bismuth, for instance, there can be no question of the evolution of the heat necessary for the fusion of the metal.

It seems to me to be quite safe to conclude that it is proven that *solid* metals possess the power of reacting on each other, and forming alloys, provided their particles are really in contact.

We have seen that metals may be made to unite either by compression or by fusion. The formation of alloys by the electrolytic deposition of the constituent metals cannot be dealt with in this brief course of lectures.

We must now examine more closely the mutual relations of the metals when united. Metals may be mixed in the fused state, but it by no means follows that they will remain in admixture if they are allowed to cool slowly, or sometimes even rapidly. In fact, a cooling mass of mixed metals often behaves much as water containing suspended matter does in freezing, when the ice, first formed, rejects the foreign matter, and, as has been shown by the classical researches of Levol,* the portion of the alloy which first solidifies rejects certain other portions of the constituent metals. Take this case of lead and zinc, the metals were thoroughly mixed in the fused state, and yet, on slow cooling in a deep mould, the separation has been almost complete, and you will see that it is easy to break off one corner at the side where the zinc has separated itself, and flatten out another one, which proves it to be nearly pure lead. Take, again, this case of what was a triple admixture of lead, antimony, and copper, thoroughly mixed when fluid, and cooled in a cylindrical mould. The copper and the antimony unite, but they reject nearly all the lead, and drive it to the centre of the mass, so that the solidified cylinder, when broken across, looks like this diagram (Fig. 2),

FIG. 2.

which represents a ring of the purple copper-antimony alloy surrounding a core of lead. Silver and copper alloys behave in a similar manner, but in any mixture of fused silver and copper, one particular alloy of silver and copper is formed, this is driven outwards or inwards in the cooling mass according to whether silver or copper is in excess in the bath. In all these cases the separation is never complete, the lead retains some 1·6 per cent. of zinc, and the zinc about 1·2 per cent. of lead. The copper and antimony retain a small amount of lead, and the lead a small amount of copper and antimony, as is shown by some very careful experiments of my assistant, Dr. E. J. Ball, which have been recently pub-

* "Bul. Soc. Chim," Paris, 1884, t. xli., p. 488.

* Levol, "Ann. de Chim. et Phys." [3] t. xxxvi. W. Chandler-Roberts, "Proc. Roy. Soc." 1875. Vol. xxiii., p. 481.

lished.* The solid mass in all three cases is a mixture of solidified solutions of the metals in each other.

The late Dr. Guthrie investigated this side of the problem at some length.† It is difficult to give a brief account of his work, but his conclusions may be stated as follows. He considers that certain alloys in cooling behave as a cooling mass of granite would; clear molten granite would throw off in cooling "atomically definite" bodies, leaving behind a fluid mass which is not definite in composition, as the quartz and the felspar undergo solidification before the mica. In alloys much the same thing happens, for when a molten mass of lead and bismuth or bismuth and tin cools, a certain alloy of the metals falls out, just as the quartz and felspar did, and ultimately the most fusible alloy of the series is left, which Dr. Guthrie called the eutectic alloy. It is the most fusible alloy of the series, but the proportions between the constituent metals are not atomic proportions, and Guthrie says that "the preconceived notion that the alloy of minimum temperature of fusion must have its constituents in simple atomic proportions, that it must be a chemical compound, seems to have misled previous investigators;" but he adds, "that certain metals may and do unite with one another in the small multiples of their combining weight may be conceded; the constitution of eutectic alloys is not in the ratio of any simple multiple of their chemical equivalents, but their composition is not on that account less fixed, nor are their properties the less definite."

Guthrie only dealt with alloys of low melting points, such as the fusible metals, and it remains to be seen whether the observation will apply to alloys with higher melting points. My impression is that it does apply, at least to the silver-copper alloys, which melt below 940° C. For further information upon this point we must wait for the development of Mendeléef's theory of solution.‡ He regards solutions as strictly definite, atomic, chemical combinations at temperatures higher than their dissociation temperatures. Definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences; the same phenomenon occurs in solutions; at ordinary temperatures they can be either formed or decomposed.

* "Chem. Soc. Journal," Feb., 1888, p 167.

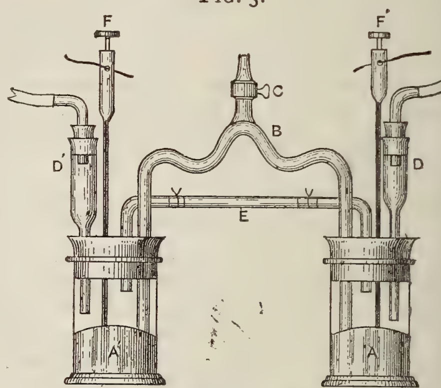
† "Phil. Mag.," June, 1884, p. 462.

‡ "Chem. Soc. Journal," 1887, p. 778.

In further tracing the analogies between alloys and saline solutions it will be well to see what takes place when a current of electricity is passed through an alloy. Take first the case of a fluid alloy through which a current is passed; we have spoken of alloys as solutions, if they be ordinary chemical solutions it has been urged that an electric current of sufficient strength ought to decompose them, and it becomes a most important question to determine whether an ordinary metallic alloy can conduct electrolytically like a salt solution, or whether it conducts, as a metal would, that is without being decomposed.

The question therefore arises, can a well-marked alloy, or a quasi-compound, be in the slightest degree electrolysed by an exceedingly intense electric current? Some experiments conducted by M. Gérardin,* in 1861, satisfied him that amalgams of sodium and mercury might be decomposed by an electric current, with partial separation of the constituent metals. The experiments were repeated by Dr. Obach,† who employed the apparatus shown in the diagram (Fig. 3). The com-

FIG. 3.



The sodium amalgam is enclosed in the glass vessels, A A', and metallic communication between them is secured by opening the stop-cock, C, and sucking the amalgam into the bent tube, B. An atmosphere of dry hydrogen is provided by means of the tubes, D D', and the connecting tube, E. The current is transmitted through the amalgam by the battery terminals, F F'. Subsequent examination of the sodium amalgam proved that no separation had been effected by the current.

position of the amalgam was unaltered by the passage of the current. He also used a W-shaped tube containing melted alloys, and proved that no decomposition could be observed after the passage of the current.

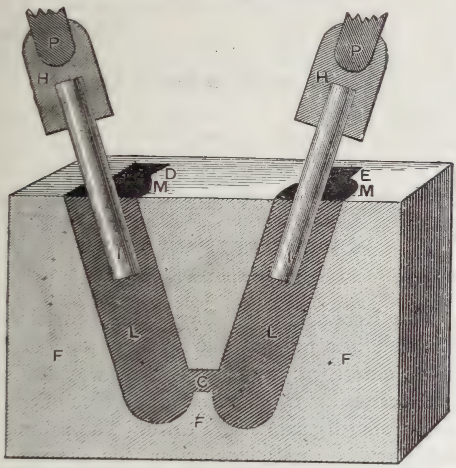
Last year, at the request of the Electrolysis

* "Comptes Rendus," t. xliii. (1861), p. 727.

† Poggendorff's "Ann. der Phys. u. Chemie.," Sup. vol. vii. (1876), p. 280.

Committee of the British Association, I took up the inquiry,* and by employing an intense electric current from secondary cells, showed that no separation took place in either certain alloys of lead and gold, or in alloys of lead and silver, even with so strong a current as 300 ampères. The method employed is indicated by the diagram (Fig. 4). The

FIG. 4.



The alloy under examination is enclosed in the cavities, L L', cut in a fire-brick, F F F. The cables from the secondary battery, P P, are connected by means of the copper holders, H H, with wrought iron terminals, I I. The cavities, E M, D M, in the block are arranged so as to enable samples of the molten alloy to be withdrawn from time to time.

experiments are given in detail in the Report of the British Association for last year, and it will be sufficient to say here that as the question at present stands, it would seem that fluid alloys conduct just like metals, and not like salt solutions; but as Dr. Lodge has pointed out with reference to these experiments, "if the question as to the possibility of the electrolytic separation of true alloys of metals should be answered in the negative, there must surely remain a group of bodies on the borderland between alloys proper and electrolytes, among which some gradual change from wholly metallic to wholly electrolytic conduction is to be looked for."

In the case of solid alloys—solidified solutions of metals, that is—the nature of the evidence is very different, for the passage of the electric current through solid alloys reveals the existence (1st) of certain well-defined compounds of the metals, and (2nd) affords abundant proof that in certain alloys the metals exist in allotropic states. And here I must go back chronologically, and refer to the classical work of Matthiessen, published in 1860.* He showed that the electrical conductivity of all alloys may be graphically represented by one or other of three typical curves, which, as the diagram indicates, are respectively U-shaped (Fig. 7), L-shaped (Fig. 5), or straight lines (Fig. 6). On adding

FIG. 5.

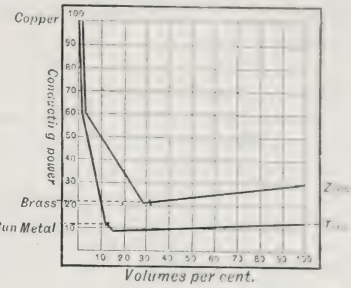


FIG. 6.

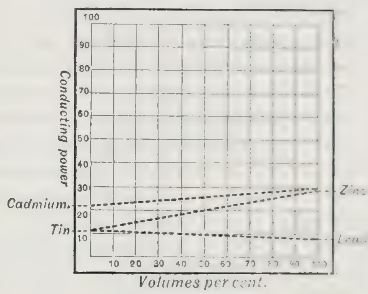
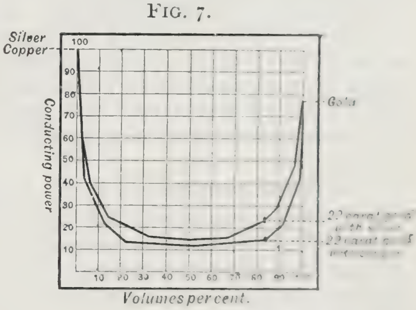


FIG. 7.



gold to silver, for instance, there is a rapid decrease of conductivity, silver being 100, and the curve gradually turns round and then rises without any break to the point representing the conductivity of gold.

In the case of the silver-copper series, silver being 100 and copper 96, there is a marked break in the U-shaped curve (Fig. 7) corresponding to the alloy, which contains 71·8 per

* Report, British Assoc., 1887, p. 341.

* "Phil. Trans. Roy. Soc.," 1860, p. 161.

cent. of silver, and this is probably a definite chemical alloy.

In the case of the L-shaped curve (Fig. 5), representing the conductivity of the copper alloys $CuSn_3$ and $CuSn_4$ (which contain respectively 61·8 and 68·2 per cent. of copper), are probably definite compounds,* and a view which is confirmed by Laurie, who has shown quite recently by another† method—by determining the electromotive force of the copper—the series that probably $SnCu_3$ is a chemically definite alloy. The nature of the evidence is as follows:—

Mr. Laurie finds that if the zinc plate of a Daniell cell be replaced by a compound plate, formed by joining copper and zinc, the cell has the same electromotive force as one in which zinc alone is used. This is true even though the zinc surface be only $\frac{1}{1000}$th part of the copper surface. If the zinc plate be replaced by copper-zinc alloys, no deflection of the electrometer is observed as long as the alloy contains less than 67 per cent. of zinc. At this point, however, a big deflection, practically equivalent to that given by zinc, is suddenly obtained. This result, in his opinion, may be taken as evidence of the existence of a compound of the two metals of the formula $CuZn_2$. Alloys containing a greater proportion of zinc behave like zinc alone. Similarly in the case of tin-copper alloys, a sudden rise of electromotive force is observed when the proportion of tin in the alloy exceeds that which would be contained in a compound of the formula $SnCu_3$. This result is in harmony with the evidence already obtained by observations of the density and thermal and electrical conductivity of the copper-tin alloys. If an alloy containing a larger per-centage of tin than $SnCu_3$, in a state of fine division, be placed in a copper cup, and used in place of the zinc in a cuprous chloride cell, the excess of tin is gradually eaten out, leaving approximately the alloy $SnCu_3$. This alloy undergoes no change if the circuit be kept closed.

Of all the researches made by Matthiessen, nearly thirty years ago, none are of more interest at the present time than those which enabled him to obtain evidence as to the existence of metals in different allotropic states in alloys.

Turn, for instance, to the tin-copper curve; he points out that the decrement in the conductivity produced by the addition of a minute quantity of tin to copper is very rapid, and he urges that the amount of tin is far too small to permit the belief to be entertained that true chemical combinations had been formed, and by such reasoning he was led to his great generalisation, that metals may sustain change in their molecular condition by union with each other in a fused state. I hope to show that this may be true, even when a "trace" of one metal is added to a molten mass, but the question of allotropy in metals and alloys must be left for the next lecture.

* See Roberts-Austen, "Phil. Mag." [5], vol. viii., 1879, p. 551; and Lodge, "Phil. Mag." [5], vol. viii., 1879, p. 554.

† "Chem. Soc. Journal," Jan. 1888, p. 104.

Miscellaneous.

BARCELONA EXHIBITION.

By H. Trueman Wood,
Secretary to the Society.

The Exhibition buildings are conveniently situated in a park at the northern end of the town, closely adjacent to the railway station, and accessible by an excellent service of tramcars from all parts of the town. The principal building is semi-circular or fan-shaped in plan. Extending from the front of this are the gardens, which contain numerous detached buildings and small kiosks for various exhibits. Along one side of the gardens are larger buildings for the fine art collections, the agricultural and horticultural exhibits, hot-houses, &c. The machinery in motion is in a separate gallery at the back of the main building, and near to this is another building containing the exhibits relating to railways and common road carriages.

From the same part of the grounds, also at the back of the main edifice, a bridge extends across the railway to a space of ground which has been laid out as a garden on the shore of the bay. In this are placed the marine exhibits, and those relating to munitions of war and to naval equipment.

The buildings are sufficiently well adapted for for their purpose, and are conveniently arranged. The principal building is divided radially into a number of courts, which are allotted to the various countries taking part in the Exhibition. The central courts are occupied by Spain, those at either end of the building being given to foreign countries. Taken as a whole, the Exhibition is one of considerable interest and great merit, but until quite recently the paucity of visitors has been surprising. It does not appear that an

accurate record has been kept of the numbers attending, and it is therefore impossible to find out what the numbers have actually been; but at all events during the summer the buildings, full as they were of interesting and attractive objects, were absolutely empty of visitors. Lately, however, the attendances have greatly increased, and by the latest accounts the city is crowded with visitors principally attracted by the Exhibition. Doubtless on account of the small number of visitors the exhibitors did not seem, at the time the materials for this report were collected, to think it worth while in most instances to keep attendants at their stands, and consequently but little information from this source was available while the absence of any catalogue—it is only quite recently that the catalogue has been issued—rendered it very difficult to ascertain accurately the contents of the Exhibition, or to give any account of them.

The extremely unsatisfactory character of the British Section could not but be a source of very great regret to any Englishman visiting the Exhibition. As a matter of fact, there were, as will be seen a little further on, a number of high-class British exhibits. These, however, were nearly all in the Machinery Gallery, or some other of the separate buildings, while the collection of exhibits in the so-called British Section was, with a few exceptions, by no means of a high class. The gallery was entirely void of any decoration; it was half empty; there were a few good exhibits, some of these neglected; and there were others of a very insignificant character. Had these exhibits been scattered about in the various classes of the Exhibition, as was done with most of the more important of the British exhibits, it would have been much better, and what cannot be regarded otherwise than as an unfortunate failure would have been avoided. It would seem to be a pity that representations to this effect were not officially made, and the country thus saved from a certain amount of needless discredit.

It is certainly a matter for some surprise that when most other nations think it essential to take part in Exhibitions of this character, the greatest commercial nation of the world should not consider it worth while to spend one or two thousand pounds to ensure that its industries should be put on at least an equal footing with those of its rivals in trade. The Barcelona Exhibition shows that this cannot be done without some organisation, and it is difficult to see how the organisation can be formed without official authority. If it is left to private enterprise, the matter naturally falls into the hands of speculators, who have their own interests to serve, interests not likely to be identical with those of the exhibitors or of the country generally; and if there is no organisation at all, the exhibits, even though they may be individually good, suffer from the want of it. If all the British exhibits at Barcelona had been collected together and properly arranged, it would have been shown that the exhibits of this country are—in spite of official neglect—not inferior to those of any other country; but as it is, the most important are not classified under the British flag, and those which ostensibly represent the country do it but little credit, either as regards their intrinsic merits, or the fashion of their display. Exhibitions are a valuable and not unduly costly method of advertising. In Spain, as elsewhere, British trade, once very flourishing, is suffering sadly from foreign competition. Our traders cannot afford to neglect any legitimate method of drawing attention to their wares, and there can be little doubt that for want of a trifling expenditure at Barcelona our commerce has once more missed, and our commercial rivals have once more availed themselves of, a good opportunity.

The central gallery of the main building is occupied by the Spanish official exhibits, and these may be considered as forming the most important part of the Spanish Section. They include contributions from the Government departments dealing with agriculture, mines, telegraphs, education, &c., as well as from the Ministries of War and of Marine. It may be noted that many of these exhibits, though shown by the different ministries, have not actually an official character. For instance, there are models of mines exhibited which are being worked by private companies, and the same remark applies to many of the agricultural productions also shown. The collection on the whole, however, is an extremely fine one, and serves well to show how great are the resources of Spain, resources to a large extent as yet undeveloped. The mineral wealth of the country is forcibly brought before the visitor by the fine collection of models and specimens which is here exhibited, and its agricultural riches are also well illustrated by the variety and character of products shown.

In addition to the official exhibits there are

also many fine private exhibits illustrating the principal industries of the country, more especially industries connected with wine, metallurgy, and the manufacture of cotton and wool. The collections of manufactured articles is also good; textiles, furniture, glass, &c., are well represented. These and other classes show the progress which Spain has made and is making in the arts and manufactures.

The most important contribution from France is the joint exhibit of Sèvres china and Gobelins tapestry. This, of course, is a Government exhibit. There are also some important private exhibits. Christofle has a small but choice vase of electro-plated ware; Thiebaut Frères show some fine bronzes, and there are other exhibitors of good bronzes. In addition to these are shown faiences d'art, textile fabrics, and wines. Musical instruments and furniture are also exhibited. On the whole France sends a good and varied representative collection. There is also a small gallery containing exhibits from Tunis—pottery, textiles, carpets, &c.

Germany fills one court, showing musical instruments, cutlery, wine, and chemical products.

Austria has some very fine Bohemian and other glass, and also shows furniture, &c. Hungary shows wine and flour, also pottery and furniture. Italy also shows wine and a fine collection of sculpture. In this court Salviati has a good collection of Venetian glass.

The more important exhibits of Belgium are glass and textiles. The United States has collected most of its exhibits into one court, where are shown agricultural implements, tram-cars, furniture, sewing machines, &c.

In considering the British exhibits, it may be convenient to deal first with those which are collected in the gallery in the main building to which the title of British Section is given. Messrs. Hooper, exhibiting in this part of the Exhibition instead of in the gallery assigned to means of transport, show some carriages which appear to be of the usual high character, as regards both workmanship and design, of the exhibits of this firm. Brinsmead shows pianos, and Kam (Canada) American organs. Messrs. Jennings show an excellent typical collection of sanitary appliances. Marsh Brothers have a fair case of cutlery and tools. J. Russell makes a good show of tubes. Rimmell has a small case of toilet accessories; and Bush shows a good collection of pharmaceutical products. The Humber Company, and the Coventry Machinists Company show bicycles and tricycles; and Simmons exhibits perambulators. The textile exhibits are not very striking. Bliss and Sons have a nice case of tweeds; Lister and Co. show a small collection of sewing-silks; and a small case containing samples of thread is exhibited by Greenhalgh and Sons. The Lancashire Felt Co. show samples of their productions; Bird, of Crewkerne, shows webbing; carpets are shown by Morton, of Kidderminster; Mackintosh shows india-rubber goods. Doxford and Sons exhibit a fine collection of naval models; Turk shows a nice sailing canoe, and a model; Summers also shows a few ship models, and Burgoyne a model of a centreboard sailing boat. Bliss, Beauchamp and Bliss show saddlery. Greener has a case of guns; Pigou, Wilkes, and Co. show gunpowder; and Brock and Co. fireworks. A case of surgical instruments is shown by Meyer and Metzler. Food products of various sorts are shown by the Liebig Co.; Monroe, of St. John's, Newfoundland (dried fish, potted fish, and products); the Ceylon Agricultural Association (spices); Sterling and Culbard (Indian tea); the Appollinaris Company (mineral water); Montserrat Co. (limejuice); King (dessicated soup); the Tottenham Lager Beer Co. (beer); Jensen (cod - liver oil). Maignen has a small exhibit of filters. Glass is exhibited by E. Moore, South Shields; and Maw shows a collection of tiles. Hardware of various sorts is shown by the Hull Forge Co., Arden Hill, and the Falkirk Iron Co.; and tin-plate and tinware by Gilbert and Co. Some electro-plate is shown by the Potosi Co. Nails are shown by Hadley; and the Tin Plate Decorating Co. exhibit some specimens of their productions. The Glenboig Co. show fireclay; and the Atlantic Patent Fuel Co. specimens of their fuel. Messrs. Waterlow send a few illustrations of bank-note and other printing. The *British Trade Journal* has a stand. Fleming has a small case of printing inks. Bryant and May show matches; the Rizine Co. floor polish; Atwood blacking; and Pickering polish paste. The above are, as well as could be ascertained, all the British exhibitors in this part of the building.

In the machinery section England makes a much better show; the textile machinery especially is extremely good. The firms showing such machinery are Platt Bros. (of Oldham), S. Brooks (Manchester), Hodgson

(Bradford), Dobson and Barlow, Hahlo and Liebreich, Dugdale (Blackburn), Howard and Bullough, Tatham. Messrs. Platt show a carding-engine, a Heilmann cotton-comber, a ring-frame for twist, and a ring-frame for weft, all the above being cotton machinery. They also show two self-acting mules for spinning wool. This is one of the finest exhibits in the shed. Another admirable exhibit is that of Messrs. Hodgson, who show four looms – a plain loom, a "pick and pick," a worsted coating loom, and a four-colour loom with independent drop-box. Howard and Bullough exhibit a patent flat carding-engine, a drawing-frame with electric stop motion, a slubbing-frame with electric stop motion, and an intermediate frame with electric stop motion "for preventing single," a rolling-frame, a ring-spinning twist frame, and a ring-spinning weft frame. They also show a model "bend" of a flat carding-engine, showing the device invented by the firm for setting the cards in a carding-engine. "Flats" can be set by this means to 1,000th of an inch. The device adopted is an electrical one. Another fine exhibit of textile machinery is that of Messrs. Brooks. It includes a fly-frame, two spinning-frames, one doubling-frame, and one winding-frame. Dobson and Barlow show their "Simplex" carding-engine, also a ring spinning-frame and a winding-frame. Hahlo and Liebreich show a loom and a cloth-cutting machine. Messrs. Dugdale show three looms. It will thus be seen that, though there does not appear to be anything of a specially novel character, the exhibit of textile machinery altogether is of a very high class. This is to be accounted for by the fact that the exhibitors have numerous customers in this part of Spain, which includes the district in which the principal textile industries of the country are carried on, both cotton and wool.

There are, however, some good machinery exhibits besides the textile machines. Messrs. Robinson, of Oldham, have a small but excellent exhibit of wood-working and milling machinery. The wood-working machinery includes band saws, a universal wood-worker, a moulding machine, &c. The milling machinery includes a purifier, a centrifugal pump, a bran cleaner, an elevator, and a break roller and smooth rolling mill. Gower, of Hyde, shows some machine tools and some band tools. Cowley shows some screw-cutting tackle, and Tatham and Ellis have a neat case containing parts of machines. Messrs. Baker have a working bakery; Messrs. Crossley show their gas-engines, but through a German house; Messrs. Nicholson show several Stockport gas-engines, one driving a Crompton dynamo for a small electric light installation. Barnet and Foster show some soda-water plant and a diving dress. R. Middleton (through the agency of W. S. Forrest) exhibits some hydraulic presses, cotton presses, and wine pumps. W. S. Forrest himself shows samples of "Mica" lubricating grease.

The Spanish machine exhibits are not very remarkable. France shows some wood-working machinery, some centrifugal pumps, aërated water machinery, machine tools, a calico-printing machine, and some confectionery pans. Belgium shows carding, spinning, and weaving machinery.

In the Agricultural Shed, Ruston and Proctor show semi-portable, portable, vertical, and horizontal engines, a threshing machine, and some centrifugal pumps. Hornsby shows some threshing machines, a reaper, a mower, and a portable engine. Ransomes, Sims, and Jefferies show a small horizontal engine, a vertical engine, and a double-furrow horse plough. Brown and May show a small vertical engine and a portable. These exhibits appear to be good of their class, but they are all small. The agricultural exhibits from other countries are not very important. The chief Spanish exhibits in this class are naturally wine and oil presses, with other appliances connected with the manufacture of wine.

In the section devoted to transport, Saxby and Farmer have an extremely fine exhibit of railway safety appliances, showing their interlocking points and signals. The Ashbury Railway Carriage Company show a few carriage wheels, this exhibit being very dirty and neglected. Windover, of Manchester, shows a nice victoria and a dog-cart, which also have suffered from want of attention.

In the Marine Section John Brown and Co., of Sheffield, show a propeller blade, a boiler shell, railway springs, wheels, and buffers, and rolled plates. In the same section Pain has an attractively arranged case of fireworks and rockets; and Hunter and English, of Bow, have a nice model of a floating crane. There are in this part of the exhibition some excellent Spanish exhibits. The Spanish Transatlantic Company (which runs from Barcelona) have a handsome building of their own here, containing models of their vessels, &c.

Messrs. Pooley have a large weighing-machine exhibited in one part of the grounds, and some smaller machines in the General Section. Spagnoletti and Crookes have applied their system of fire-alarms throughout the Exhibition.

CANES AND STICKS USED IN THE MANUFACTURE OF WALKING STICKS, UMBRELLA HANDLES, &c.

By J. R. Jackson, A.L.S.

(Continued from p. 1110.)

Part II.

Cherry (*Prunus cerasus*). – Of late years this has become a very important stick, both for walking sticks and sunshade handles. Two distinct forms of the cherry are known in the stick trade, namely the scented and the tiger cherry. The former has a dark brown bark, which has a peculiarly sweet scent, and in consequence, is seldom or never polished, the effect of which would, of course, be to kill the perfume. The tiger cherry has a bark with patches of a beautiful golden lustre, which is heightened by the addition of polish. These sticks are imported in large quantities from Austria and Hungary, where the growth for pipes and walking sticks constitute a staple industry.

Chestnut.—These are the branches or saplings o the Spanish chestnut (*Castanea sativa*). When peeled, the wood is of a very light colour, but is hard and durable. The sticks are obtained principally from France.

Coffee.—These sticks are the produce of the ordinary or Arabian coffee-tree (*Coffea arabica*), and are brought here from the West Indies. They are very hard and heavy, with a light-coloured bark, and have but little to recommend them.

Cork.—The produce of the cork oak (*Quercus Suber*). Though these sticks are somewhat clumsy in appearance, owing to the thick and rugged deposit of bark or cork, they are light in weight from the same reason. They are imported from Spain and Algeria.

Crab.—Two kinds of stick are furnished by this plant—the wild form of the cultivated apple (*Pyrus malus*), the plainer sticks being known as crab, and the knotted or irregular sticks as warted crab. They are the produce of our own country, though some are imported from the Continent.

Date Palm.—These are the midribs of the leaves of this well-known palm (*Phœnix dactylifera*) with the leaflets cut off, rounded and smoothed, and then polished. They are imported from Algeria.

Dogwood (*Cornus sanguinea*).—This is a well-known shrub of our own hedges, the wood of which is hard and not liable to splinter; hence it was at one time much used for butchers' skewers. These properties, together with those of rigidity and lightness, have caused the sticks to become very much in favour with walking-stick makers. On this account they are much used for the "pillars" or sticks of umbrellas and sunshades, often having other handles or knobs fixed to them. They are imported in large quantities from France, Germany, and other parts of the Continent.

Ebony.—Several kinds of ebony are known in the trade as Ceylon, Macassar, and flowered ebony. The two former are the produce of *Diospyros ebenum*, and the latter of a totally different plant, namely, *Brya ebenus*. The first is a native of Ceylon and India, and furnishes the best true ebony, while the second is a small tree, native of the West Indies, and is sometimes known as green ebony and cocus-wood, so much used for making flutes. The ebonies furnish very choice sticks, which are cut from the solid wood.

Eucalyptus.—This, as its name implies, is the produce of *Eucalyptus Globulus*, better known, perhaps, as the blue gum. It is a native of Australia, but has been introduced into many other parts of the world. The supply for the stick trade comes from Algeria.

Fuller's Teazle (*Dipsacus Fullonum*).—This plant is probably only a cultivated variety of the common teazle found wild in our copses and hedges (*Dipsacus sylvestris*). The plant is cultivated in some parts of this country, as well as in France and Germany, for the sake of the hooked bracts of the flower-heads, which are used for teasing or carding cloth. The adaptation of the stems for sunshade handles is very singular, for most of those used for the purpose are fasciated or abnormally twisted in the process of growth, so that they become double or treble their normal size. This fasciation was at one time considered to be unusual in the teazle, and their appearance a few years since in thousands as sunshade handles came as a surprise to the botanist. It exemplified, however, what has been before said, how apparently useless products can be made subservient to the demands of commerce. Teazle stems are imported from France.

Furze, sometimes also known as *Whin* or *Gorse* (*Ulex europeus*).—The stems of this common British plant are, as is well known, very irregular in their growth. When they are straightened and properly dressed, however, they make extremely pretty walking and umbrella sticks, and are in great demand.

Gru-Gru.—These are the saplings of a palm, the botanical origin of which cannot be accurately determined, inasmuch as the name gru-gru is equally applied to *Astrocaryum vulgare* and *Acrocomia sclerocarpa*, both South American species. The sticks are very beautiful, being of a rich dark brown with fine white longitudinal lines near the joints. The root-heads also are very handsome. The sticks are imported from the West Indies.

Guelder Rose (*Viburnum opulus*).—The sticks from this well-known shrub are very attractive when dressed and polished. The bark which covers them

is of a rich brown, thickly marked with white lines. They are of a comparatively recent introduction, and are very much in demand. They are sometimes known under the name of Balkan rose, being imported from the neighbourhood of the Balkans.

Hazel.—This well-known stick is the produce of *Corylus avellana*, and has quite recently increased very much in favour both for walking and umbrella sticks. A variety known as silver bark hazel is the most beautiful. The sticks are imported from various places on the continent of Europe.

Holly (*Ilex aquifolium*).—The sticks of this favourite shrub are so much used for walking sticks, whip-handles, and similar uses that they need only to be enumerated. They are chiefly the produce of our own country.

Hornbeam (*Carpinus Betulus*).—A well-known hard-wooded tree; the wood is of a very light colour, but makes durable sticks. The market is supplied by English growth.

Jambee, or *Jambeze.*—This is apparently the produce of a palm, which has yet to be determined.

Lancewood.—This wood, supposed to be the produce of *Duguetia quitarensis*, a tree of South America, is much used for shafts of carriages, whip-handles, and the top joints of fishing-rods, in consequence of its elasticity and strength. For the seme reason it is used for walking and umbrella-sticks.

Loya Canes.—The stems of an Australian palm (*Calamus australis*). They have somewhat the appearance of a rattan, to which they are a close botanical ally.

Malacca (*Calamus scipionum*).—Like the last, these are the stems of a climbing palm, imported, not from Malacca, but from Siak, on the opposite coast of Sumatra. They are a very choice stick, and fetch perhaps the highest price of any stick in the market.

Maple (*Acer campestre*).—The branches of this well-known British tree are sometimes used for walking sticks, as well as the wood of its American ally, the bird's eye maple (*Acer saccharinum*).

Medlar (*Pyrus germanica*).—Sticks of this plant are imported from France. They are sometimes covered with numerous transverse gashes, which is done in the stem during growth for the purpose of ornamentation.

Midgen.—This is the stem of an Australian palm (*Kentia monostachya*). It makes a very pretty stick, from the markings or scars of the fallen leaves being very close together.

Mountain Ash.—A well-known ornamental tree of our shrubberies (*Pyrus Aucuparia*). The sticks are slender but strong.

Mountain Bay.—A slender palm, the source of which is unknown.

Myall Wood (*Acacia homalophylla*).—A leguminous tree of Australia, the violet-scented wood of which is well known and has been much used of late in the manufacture of pipes. The sticks are not polished so as to preserve the scent.

Myrtle.—Whether this is the produce of the *Myrtus communis* is somewhat doubtful. It makes excellent walking and umbrella sticks, which are imported from Algeria.

Nana Canes.—This name has been given to the hollow reed-like stems of *Arundo donax*, the rhizomes of which form excellent handles for umbrellas and sunshades. They are imported from Algeria.

Oak (*Quercus Robur*).—The saplings and branches of this well-known British tree are much used for walking sticks, and are always in demand. Under the name of Brazilian oak, a stick that has met with a very large demand has been known in the market for some few years. It is corrugated longitudinally, and knotted throughout, the knots being especially thick near the knob. Though this stick is a great favourite, its botanical origin at present is obscure. It is imported from Bahia, and is sometimes known also as Ceylon vine.

Olive (*Olea europea*).—This is another favourite stick for which there is always a large demand; the dark green bark has a character of its own, and the brown markings of the wood, when stripped of its bark, has much to recommend it. Olive sticks are imported chiefly from Algeria.

Orange.—The orange sticks, which are imported chiefly from Algeria, are probably the produce of other allied species besides that of the common orange (*Citrus aurantium*). The bark of the orange, when dressed and polished, has a bright, greenish colour, with white streaks, and makes extremely pretty sticks, for which there is a constant demand.

Orange, Black.—This is a distinct product from the foregoing, and is not furnished by any species of *Citrus*, but by the common broom (*Cytisus scoparius*) The bark has somewhat of the orange marking, but its colour is nearly black, as its trade name indicates. It is imported from Algeria.

Palmyra.—These sticks are cut from the solid wood of the palmyra palm of India (*Borassus flabelliformis*). Two varieties are known, black and red, the one with intense black lines, the other with red. The wood is imported from India.

Partridge Canes.—Under this name an immense quantity of canes, with and without the bark, are annually imported from China. Though they are a specially favourite stick for walking, umbrellas, and sunshades, the botanical source still remains unknown. They are largely used for the twisted and curled handles now so much in vogue.

Partridge Wood (*Andira inermis*).—This is a large tree of the West Indies. The wood is close-grained and hard, and takes a good polish: it is used chiefly for umbrella handles.

Penang Lawyer (*Licuala acutifida*).—This is a palm, the saplings of which, with the roots attached, are imported in considerable quantities from Penang.

Pimento (*Pimenta officinalis*).—A tree common in Jamaica, where it is largely cultivated for the sake of its fruits, which are the allspice of commerce. For the stick and umbrella trade large quantities of the

young saplings are imported from the West Indies. The sticks are valued specially for umbrella handles, in consequence of their rigidity and non-liability to warp.

Pomegranate (*Punica Granatum*).—These sticks come mostly from Algeria, where they are specially cultivated.

Rajah Cane.—This favourite stick has been known in commerce for some twenty years or more. It is imported from Borneo, and for a long time after its introduction its botanical origin remained a mystery. It has, however, since been referred to the genus of palms *Eugeissonia*, and probably to the species *minor*. The commercial name rajah is said to be derived from the fact of the duties paid for its export being claimed by the Rajah of Borneo.

Rattan.—Under this name a variety of sticks, apparently the produce of different species of *Calamus*, are known. Thus we have root rattans, white hard-barked rattans, monster rattans, miniature rattans, and so on. They are all of a similar character, with the scars of the fallen leaves strongly marked in transverse rings. They are the produce of Eastern countries.

Snakewood (*Brosimum Aubletii*).—This is also known under the name of letter-wood and leopard-wood. It is the produce of a large tree, native of Guiana, Northern Peru, Brazil, and Trinidad. The wood is extremely hard, of a reddish-brown colour, marked with dark transverse blotches. It makes one of the handsomest sticks known, and when mounted with gold has a very rich appearance. A very fine block of this wood is exhibited in the Timber Museum at Kew.

Thistle.—Under this name the stems of the mullein (*Verbascum Thapsus*) are known in commerce. They are slender and very light, both in colour and weight; they are, however, very prettily marked, and make good handles for umbrellas.

Tonquin Canes.—These are slender-jointed sticks of the character of bamboos, and are the produce of an unknown species of *Arundinaria*. They make light and strong sunshade handles, and are very much used for that purpose. They are imported from China.

Whangee.—This is a well-known cane imported from Japan, and is formed of the rhizome or underground stem of a kind of bamboo (*Phyllostachys nigra*). The cane is very pliable, and is very distinctly marked by the transverse scars of the young shoots, where they have died out, and where the rootlets have fallen off. The canes are mostly of a pale yellow colour, but there is a variety with black canes known as the black whangee.

Whitethorn.—This is another name for hawthorn (*Cratægus Oxyacantha*). The wood is very hard and close-grained, and makes very strong sticks.

Zirracote.—A close-grained, nearly black wood; used mostly as a cabinet wood. It takes a good polish, and has a very handsome appearance.

From the foregoing notes it will be seen how extensive are the resources of the walking and umbrella stick trade at the present time, and how the forests and jungles of the world are laid under contribution to supply the material.

The following estimate of the annual imports of some of the principal canes from the East here referred to will further illustrate its commercial importance:—

Description.	Country.	Approximate quantity.
Bamboos	China and Japan	5,000,000
Partridge canes	China	2,500,000
Tonquin canes	China	20,000,000
Malacca	Siak	250,000
Whangee	Japan	600,000
Rattan	Singapore	100,000
Other Eastern canes	China, &c.	500,000
		28,950,000

Besides these, the number of various kinds of rattan canes imported from Singapore and other Eastern countries amount in weight to about 1,500 tons, while of sticks other than canes, we have of olive, myrtle, orange, and various kinds from Algeria, as many as 2,000,000; and of hazel, dogwood, cherry, &c., from Austria, Hungary, and France, about 3,000,000. The total value of the sticks in the raw state imported from all countries may be estimated at about £300,000.

Correspondence.

MATCH INDUSTRY IN EUROPE.

Mr. GEORGE S. ALBRIGHT, of the Phosphorus and Chemical Works, Oldbury, writes:— "In the article entitled the 'Match Industry in Europe,' p. 1093 of the *Journal* of our Society for September 28, I notice the statement that the *Compagnie Générale des Allumettes Chimiques* consumes 300,000 kilos. phosphorus. I am in a position to state that the actual figure is only 30,000, both for wooden and wax matches."

[The number 300,000 is that given in the *Journal de la Chambre de Commerce de Constantinople*, from which the information in this article was obtained.—ED.]

General Notes.

SCHOOL OF WOOD-CARVING.—The School of Art Wood-carving, City and Guilds' Institute, Exhibition-road, South Kensington, has been re-opened after the usual summer vacation, and one or two of the free studentships in the evening classes, maintained by means of funds granted to the school by the Institute, are vacant. To bring the benefits of the school within the reach of artisans, a remission of half fees for the evening class is made to artisan students connected with the wood-carving trade. Forms of application for the free studentships, and any further particulars relating to the school, may be obtained from the manager.

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FRIDAY, OCTOBER 19, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

Prizes are offered to Art-workmen in the following classes :—

I.—Pottery (including Porcelain and Earthenware).

1. The Body, any material.
   a. Thrown, not shaved, first prize, £5 ; second prize, £2.
   b. Shaved or turned, first prize, £5 ; second prize, £2.
2. Decoration.
   a. Modelled and glazed, first prize, £10 ; second prize, £5 ; third prize, £3.
   b. Painted under glaze, first prize, £10 ; second prize, £5 ; third prize, £3.
   c. Enamel on the glaze, first prize, £10 ; second prize, £5 ; third prize, £3.
3. Stone salt-glazed ware.
   a. Plain ; incised and glazed, first prize, £10 ; second prize, £3 ; third prize, £3.
   b. Coloured or otherwise decorated, first prize, £10 ; second prize, £3 ; third prize, £3.

The Art-workman must have designed the body of the pot as well as have executed the decoration.

All the specimens of pottery sent in for competition must be dated on the clay.

II.—Stone Carving.

First prize, £25 ; second prize, £15 ; third prize, £10 ; fourth prize, £5.

The capital of a column, with square, circular, or octagonal abacus, not to exceed twelve inches in width.

III.—Wrought-Iron Grilles.

First prize, £25 ; second prize, £15 ; third prize, £5.

A grille measuring not less than three feet superficial, nor more than five feet superficial.

The object for which the grille is intended must be stated—whether for a protective purpose, for the outside of a window, for a street-door panel, or for indoor use as a window screen, coil case, ventilator, &c.

IV.—Goldsmiths' and Silversmiths' Work.

[Prizes presented by the Goldsmiths' Company.]

A cup or sugar basin of beaten silver, chased or otherwise, made within the year 1888. First prize, £20 ; second prize, £5.

A pendant or brooch, or locket of gold without gems. First prize, £20 ; second prize, £5.

All articles for competition must be sent in to the Society's House on or before Tuesday, April 23rd, 1889.

The conditions under which these prizes are offered have appeared in previous numbers of the *Journal.** They can also be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Professor W. Chandler Roberts-Austen, F.R.S.

Lecture II.—Delivered March 19, 1888.

The last lecture ended with a reference to the evidence which led Matthiessen to conclude that in certain cases the union of metals with each other must be attended with their passage into allotropic states. This is probably the most important generalisation which has hitherto been made in connection with the study of alloys, and I propose to devote this lecture to the consideration of this question of the molecular change in metals. It may be well to begin by a reference to some early views as to the constitution of metals, and I

* See *Journal*, June 15.

will ask you, therefore, to look at the surface of this mass of antimony which is adorned with a large crystalline star. An attempt to explain the origin of the star arose from a very early investigation into the structure of metals, and drew from Robert Boyle, in 1663, a protest against the supposition that "a certain respect to times and constellations is requisite to the production of this admirable body," as he called it. (Opera, Ed. 1772, vol. 1, p. 325.) Lemery, a little later, in 1675 ("A Course of Chemistry," English Ed., 1686, p. 212), pointed out that "the star which appears upon antimony when it is well purified has given occasion to chymists to reason upon the matter, The greatest part of these men being strongly persuaded of the planetary influences, have not wanted to assert that this same star proceeded from the impression which certain little bodies flowing from the planet Mars do bestow upon antimony for the sake of the remaining iron that was mixed with it, and for this reason they wonderfully recommend the making of this preparation upon Tuesday rather than another day, between 7 and 8 o'clock in the morning . . . provided the weather be clear and fair." He adds:—"My thoughts . . . shall not soar so high as these men's do; . . . I shall not search the celestial bodies for an explication of the star we now contend about, seeing that I can find it in causes near at hand. . . . I say, then, that the star doth proceed from the antimony itself; the purification of the metal does serve to lay open the crystals of antimony, and the iron (it contains) by its hardness does expatiate these crystals." This attempt of Lemery to explain the development of a crystalline structure in a metal by the influence which the presence of a small quantity of a metallic impurity exerts, will serve as a fitting introduction to the class of facts I want to bring before you to-night, the study of which has been much neglected, notwithstanding their importance in metallurgical industry.

All I can do is to set before you some evidence which may serve to throw light upon the question why a definite material actually employed in the manufacture of, say, a bridge or a weapon, can be depended upon to perform the duty entrusted to it, and why a certain other material would be absolutely untrustworthy, although chemical analysis can barely show the difference between the two. It has long been known that the properties of a metal may be influenced by the presence of a minute quantity of another element, even though it is so small as to preclude the possibility of its action being due to the formation of an ordinary chemical compound to which any reasonable formula, based upon atomic proportions, could be assigned. It by no means follows, however, that the atom of the added element does not exert a direct influence, or that its action is not controlled by a well-known law, but it is clear that in the experiment I am about to make, for instance, we are not dealing with the union of elements in atomic proportions. Here are two ladles containing exceptionally pure bismuth; they have been, as you see, filled from the same crucible containing the molten metal, and into one ladle I will introduce this tiny fragment of tellurium suspended above the molten mass of metal in one ladle. The contents of both ladles will be poured into moulds, and when the metal is cold it will be fractured. You will see that the bismuth to which the tellurium is added has become minutely crystalline, while that which remains pure has crystallised in broad, mirror-like planes, and one reflects a ray of light like a mirror, while the one containing the tellurium scatters the light. If we had no other guide than that afforded by mere inspection, you would say that the two masses were totally distinct elemental substances, and yet the only difference is that one contains $\frac{1}{2000}$th part of tellurium, and the other does not.

There are many such facts to be met with in practical metallurgy, and the knowledge of them has been steadily accumulating for centuries, but it is only since the end of the last century that it can be said to have been built up on a scientific basis, for it was not until 1781 that Bergmann discovered the wonderful fact that the difference between wrought iron and steel depends upon the presence or absence of a small quantity of carbon. The smallness of the amount of carbon capable of producing such striking effects greatly astonished him, and the chemists who followed him and repeated his experiments, but, strange as it may seem, the promulgation, in 1803, of Dalton's atomic theory threw a flood of light upon chemical phenomena, but cast into shade such investigations as those of Bergmann which dealt with influences of traces upon masses, and the authority of Berthollet was not sufficient to save them from neglect. In this eventful year for science, 1803, the latter published his essay on chemical statics, in which he stated, as a fundamental proposition, that in comparing the action of

bodies on each other, which depends "upon their affinities and mutual proportions, the mass of each has to be considered."* His views were successfully contested by Proust, but, as Lothar Meyer says, the influence on chemistry of the rejection of Berthollet's views was remarkable, "All phenomena which could not be attributed to fixed atomic proportions were set aside as not truly chemical, and were neglected. Thus chemists forsook the bridge by which Berthollet had sought to unite the sister sciences, physics and chemistry." Fortunately, however, in this country there was one chemist who had followed up the line of work indicated by the early metallurgists, for in 1803, the same year as that in which Berthollet's essay was published, Charles Hatchett† communicated to the Royal Society the results of a research which he had conducted, with the assistance of Cavendish, in order to ascertain "the chemical effects produced on gold by different metallic substances when employed in certain" (often very small) "proportions as alloys." I shall subsequently refer to Hatchett's work.

Before we can investigate the nature of the action of traces of an element on masses of other elements, we must consider some facts bearing on the relation between atoms and molecules. Let these glass spheres which are spread out before you represent the atoms of which the molecules of an element are composed. If we could change at will the mass of the individual atoms, or if we could diminish or increase at will the velocity with which the atoms move, it might be possible to transmute one elemental substance into another, and the object of the alchemist would be realised.‡

The progress of research may show that it is possible, by a sufficiently high temperature, or by a suitable application of heat, to modify the number or form of the atoms into which the molecule is split up, and in this way to resolve one elemental substance into another; at present we only know with certainty that we can change the grouping of the atoms in a molecule, but cannot alter the atoms themselves. That such change in the grouping of atoms is possible has long been known.

Berzelius made it clear that bodies having exactly the same chemical composition possess widely different chemical and physical properties. Here is a mass of black sulphide of mercury, here the red sulphide. Chemical analysis shows no difference between them, and yet their aspect is widely different. Many similar cases present themselves in the range of organic compounds, as Dr. Tidy has reminded us by a reference to narcotine and peperine, the former being the very substance to send you to sleep, and the latter to keep you awake, notwithstanding that composition is identical, although the grouping is different. To such bodies as the red and black sulphides of mercury the term isomeric is applied.

It is now, I think, recognised that, except in the case of unstable forms of elements, the occurrence of elements in different allotropic states means that, in the respective cases, the atoms are differently arranged in the molecules of which the body is composed. I need not dwell upon these definitions here; all I want to insist upon is the great industrial importance of the change in the molecular conditions of metals and alloys, produced, as these changes are, by comparatively slight influences. It may help us to remember the importance of the subject if we bear in mind that the moral significance of allotropy, or rather of isomerism, has been recognised by one of the most subtle and refined writers of modern times, for the "Strange Case," related by Mr. R. L. Stevenson, shows us what might happen if the same human being revealed alternately two entirely different natures and attributes. I have not hesitated to refer to this, because certain metals may, under slight influences, be made to assume forms in which, as regards special service required from them, they behave either usefully or entirely prejudicially.

With regard to metals, chemists have, even to present day, been very slow to examine the conditions under which a metal, when pure, can exhibit widely different properties—can pass from one allotropic state, as it is termed, to another. Berzelius claimed that the metals osmium and iridium could exist in different allotropic states; and in 1846 Joule and Lyon Playfair* showed that certain metals in different allotropic states possessed different volumes; and although chemical analysis could detect no change in the composition of a particular metal in either of its different states, its properties were widely different. I have here several instances of this. In 1849, Bolley taught us to prepare lead in this form by electrolysis. It is as pure as this piece of sheet lead; but Bolley's lead oxidises rapidly in air, and becomes converted into a yellow

* English Edition (by M. Farrell, M.D.), 1804, p. 5.

† "Phil. Trans.," vol. 93, p. 43, 1803.

‡ Consult also "Kopp, Die Alchemie in älterer und neuerer Zeit," vol. ii, 1886, pp. 174—178.

* "Memoirs of the Chem. Soc.," vol. iii, p. 57.

powder, and sheet lead, we know, does not. Here is a form of copper which was first prepared in 1878 by Schützenberger; its specific gravity is less than that of ordinary copper; it oxidises rapidly in air; its behaviour in relation to nitric acid is different from that of ordinary copper, and last, it may be converted into ordinary copper by prolonged contact with dilute sulphuric acid. Similar cases of allotropism are claimed by Fritsche for tin, and for silver by Schützenberger.* I have not specially alluded to Gore's antimony, or to modifications of nickel and palladium, because in their cases the passage from one state to another is determined by the presence or absence of occluded gas, and therefore the phenomenon becomes more complicated than when the composition of the metal is unchanged. It is quite true that in the cases I have referred to the variations in properties—the allotropy of the same element—are far less marked than the variations which characterise isomerism of organic compounds; but they are, nevertheless, very real and important, and if we knew the metals I have mentioned only in their unstable conditions, they would be unfit for industrial use. Imagine a vessel sheathed with Schützenberger's copper, or a cistern lined with Bolley's lead—disintegration and disaster would rapidly ensue in either case.

Fritsche found that certain ingots of tin, when exposed to the rigour of a Russian winter, fell into powder. This powder was certainly an allotropic form of tin; it was grey and needle-like, but by heating to a point far below its melting point it became changed into ordinary tin; and Fritsche points out that this property which tin possesses of passing into an unusual condition led on one occasion to some difficulty. A quantity of buttons, consisting mainly of tin, and intended for the adornment of military uniforms, were safely delivered by the manufacturer and placed in store. On inspection, however, by the military authorities nothing but a shapeless mass of grey powder remained, for the tin had assumed its allotropic form, and the buttons disappeared. Specimens of such tin I have seen, but I regret that I have not been able to obtain a fragment.

We may now consider the question, Do metals, when they enter into union with each other, preserve their normal conditions, or do they in any case assume allotropic states? The experimental evidence that they do is somewhat difficult to obtain, but I will endeavour to set some facts before you.

Joule proved that when iron is released from its amalgam by distilling away the mercury, the metallic iron takes fire on exposure to air, and is therefore clearly different from ordinary iron, and is, in fact, an allotropic form of iron. Moissan* has shown that similar effects are produced in the case of chromium and manganese, cobalt, and nickel, when released from their amalgams with mercury.

Evidence is not wanting of allotropy in metals released from solid alloys, as well as from fluid amalgams with mercury. Certain alloys may be viewed as solidified solutions, and when such bodies are treated with a suitable solvent, usually an acid, it often happens that one constituent metal is dissolved, and the other released in an insoluble form. Here is a new alloy of potassium and gold, containing about ten per cent. of the precious metal. If a fragment of this alloy be thrown upon water, the potassium takes fire, decomposes the water, and the gold is released as a black powder; there is a form of this black or dark brown gold which is, I believe, an allotropic modification of gold, as there is evidence that it combines with water to form auric hydride. By heating this dark gold to dull redness, it at once assumes the ordinary golden colour. The Japanese use this gold, released from gold-copper alloys, in a remarkable way (Fig. 8), for they produce, by the aid of certain pickling solutions, a beautiful patina on copper which contains only two per cent. of gold, while even a trace of the latter metal is sufficient to alter the tint of the patina.

FIG. 8.

The diagram represents a portion of a Japanese knife handle in the collection of Mr. Marcus B. Huish. It consists of *Shi-bu-ichi*, an alloy containing about equal parts of silver and copper. The duck is of *Shakudo*, the alloy of copper with from 1 to 5 per cent. of gold. By "pickling," a grey patina is given to the *Shibuichi*, and a purple patina to the *Shakudo* duck, the arrangement being so skilful that the neck of the duck appears to be beneath the water, and is only seen when the handle is held towards the light in certain directions.

The best illustration I know of the change produced in a metal by the action of mercury is afforded by the following experiment,

* "Bull. Soc. Chim., Paris," t. xxx., 1878, p. 3.

* "Comptes Rendus," T. lxxxviii. p. 180, 1879.

for which I am indebted to Mr. Laurie, to whose work in another direction I referred in the last lecture. This plate of metallic aluminium would, as you know, long remain exposed to air without sensible oxidation. Mercury also does not oxidise at the ordinary temperature, when exposed to air, but if the surface of this plate be covered with a layer of mercury, then oxidation rapidly ensues, and the plate will soon become covered with a white film of alumina, which may be detached in flakes. Clearly, the condition of the aluminium has been modified by its union with the mercury.

You will remember that in the last lecture we saw that water could be frozen by the solution of finely divided fusible metal in mercury. It is not a matter of indifference whether the powders of the mixed constituents of the alloy are employed, or whether the alloy is previously prepared by fusion, and then powdered, which shows that the act of fusion has effected some change in the molecular arrangement of the metals; a point I am investigating, hitherto with somewhat conflicting results. The explanation of the depolymerisation of metals, when they are united with each other, is somewhat complicated, but I will attempt it with as much brevity as possible. First Mazzetto* has shown that there is a similar lowering of temperature, though to a far less extent, when molten tin is mixed with molten lead, so that the lowering of the temperature is by no means confined to the solution of metals in mercury. The next step we owe to Professor W. Spring, of Liège, whose results in building up alloys by compressing the powders of their constituent metals, as I showed you in the last lecture. Spring finds that by determining the amount of heat given out by alloys of lead and tin on cooling from a molten state, that more heat is actually given out than might be expected from the results of calculation;† the difference is so great, that it could not be due to errors of observation, for in actual numbers it amounts to many hundreds of calories for a weight of 100 grammes. He concludes that when molten tin is added to molten lead, the atomic constitution of the molecules is simplified, that is, depolymerisation takes place. Let it be assumed that each molecule of molten lead contains an arbitrary number of atoms, say five atoms, and that the molecule of molten tin also contains five atoms. If one molecule of lead be added to three molecules of tin, so as to form the alloy Pb Sn_3, five groups of Pb Sn_3 will be the result, but each molecule of the alloy will contain four atoms instead of five, as this diagrammatic model shows. This molecular change, which I have effected by pulling the atoms asunder, requires heat to do the work of re-arrangement in the molten admixture of metals, and as this heat is absorbed, cold is produced, and it will therefore be evident that both theory and experiment lead to the view of molecular change produced by alloying metals.

[The nature of the molecular change resulting in the absorption of heat which attends the admixture of molten lead and tin, and the evolution of heat which is observed when alloys of these metals solidify, was demonstrated to the audience by means of diagrams and models which it would be difficult to describe here. The reader is therefore referred to Professor Spring's paper cited above. The subject is complicated by the possibility of chemical combination in the case of certain alloys such as Pb Sn_3.]

Debray* has given us a case of an alloy in which a simple elevation of temperature induces allotropic change in the constituent metals. It is prepared as follows: ninety-five parts of zinc are alloyed by fusion with five parts of rhodium, and the alloy is treated with hydrochloric acid, which dissolves away the bulk of the zinc, leaving a rich rhodium-zinc alloy, containing about 80 per cent. of rhodium. When this alloy is heated in vacuo to a temperature of 400° C., a slight explosion takes place, but no gas is evolved, and the alloy is then insoluble in *aqua regia*, which dissolved it readily before the elevation of temperature caused it to change its state. We are thus presented with another undoubted case of isomerism in alloys, the unstable, soluble modification of the alloy being capable of passing into the insoluble form by a comparatively slight elevation of temperature. [Experiment shown.]

We have seen allotropic states produced in metals by their release from their amalgams, and from alloys with each other, and I have given you evidence of polymerisation induced by the act of alloying metals. We have just examined a case in which simple elevation of temperature is sufficient to cause molecular change in an alloy. There is, therefore, firm experimental basis for the view to which Matthiessen was guided, nearly thirty years

* "Rendiconti del R. Instituto Lombardo" [2], vol. xviii., No. 3.

† "Bull de l'Acad. Roy. de Belgique" [3], t. xi. No. 5, 1886.

* "Comptes Rendus," xc., 1880, 1195.

ago, by a study of the electrical resistance of solid alloys, that when metals are united to form alloys, in many cases one metal, and sometimes both metals, assume the allotropic state. He showed, for instance, that silver has a conductivity represented by 100, the addition of a small quantity of gold to the silver is attended with a rapid fall in the conducting power. The conductivity of pure copper may be represented by the number 98, the addition of a small portion of tin greatly diminishes the conductivity, as is proved by the curves given in the last lecture. He points out that the amount of tin is too small to admit of the possibility of a chemical compound being formed, and from this fact and other evidence he concludes that the passage to an allotropic state can alone explain the result. This leads me to speak of the influence of small quantities of one element on large masses of another. You may say does it matter after all; grant that a metal may assume an allotropic state in virtue of the presence of a small quantity of foreign matter hidden in it? Is the mass any the worse or better, are its physical or mechanical properties greatly modified? Submarine telegraphy will present us with the first case. It may sound strange, but the commercial success of a submarine cable is measured by the speed with which messages can be sent through it, and upon this point we have the testimony of Mr. Preece, who tells us that a cable made of the copper of to-day, when the necessity for employing pure copper is recognised, will carry twice the number of messages that a similar cable of less pure copper would, in 1858, when the influence of impurities in increasing the electrical resistance of copper was not understood. A paper by Sir W. Thomson* shows how important the purity of copper is, and how obscure is the mode of action of the impurity. I believe it is safe to say that the presence of $\frac{1}{10}$ per cent. of bismuth in the copper would, by reducing its conductivity, be fatal to the commercial success of the cable.

The influence of small quantities of foreign matter is more marked in the case of iron. Steel differs from iron, as you know, by containing a small quantity of carbon. If you introduce into the iron $\frac{2}{10}$ths per cent. by weight of carbon, you produce a material which would make an excellent bridge or a boiler plate, but if fashioned into a weapon would be absolutely untrustworthy, for it would bend, as this worthless sword did, when very moderate demands were made upon it. On the other hand, if you introduce $\frac{8}{10}$ths per cent. of carbon, you obtain a material from which a good razor might be made; but it would be useless for a rail or for the construction of a bridge.

I will now appeal to gold. The addition of $\frac{2}{10}$ths per cent. by weight of bismuth would, from the point of view of coinage, convert the gold into a useless material, which would crumble under the pressure exerted through the die. Instances of a similar nature might be multiplied indefinitely. I will only quote a statement of Sir Hussey Vivian, who says that $\frac{1}{1000}$th part of antimony will convert best select copper into the worst conceivable. Here is a sample of the alloy called "yellow metal," which would certainly have been condemned, because its fracture affords evidence of the presence of the $\frac{1}{1000}$th part of antimony, which is found to prejudice the working properties of the alloy.

Is it possible to explain facts such as these? We have seen that comparatively slight variations in external conditions can affect the atomic arrangement of metals, and we must now ascertain what relations may subsist between the atoms of the mass of metal, and the atoms of the added impurity. First, as regards the cohesion of a metal, this property may be investigated by the aid of heat, or by submitting the metal to mechanical stress; and in a research to which I have devoted much time I selected tenacity as the property to be tested, with a view to ascertain the effect of the added matter upon a metal or alloy when an attempt is made to pull the metal asunder in an ordinary testing machine.* Gold was chosen as the subject of the experiment for the following reasons:—First, it is a metal which it is possible to purify in a very high degree, it is not liable to oxidation, and the accuracy of the results is not affected by the presence of occluded gases. The purest gold has a tenacity of 7 tons to the square inch, and it elongates about 25 per cent. before breaking. Standard gold which contains over 91 per cent. of gold, the alloying metal being copper, has a tensile strength of 18 tons per square inch, and it stretches 30 per cent. before breaking; in fact, when an eminent engineer saw the results of these tests, he expressed an opinion as to the possibility of making a very good gun of standard gold if the cost of the material were no object. When, however, a small quantity of certain metals,

* "Proc. Roy. Soc.," vol. x., p. 301, 1860.

* Proc. Roy. Soc., vol. 43, p. 425, 1888.

$\frac{1}{100}$th, $\frac{1}{10}$th, or $\frac{2}{10}$ths per cent. be added to the gold, the cohesion of the metal is reduced in a very remarkable way, as Hatchett showed to be the case in 1803. This bar contains 100 sovereigns melted with $\frac{1}{10}$th per cent. of lead; you see that its cohesion is reduced to a very low point, for it is as brittle as can be. I have tried the effect of adding to pure gold other metals and metalloids than lead, introducing in each case as nearly $\frac{2}{10}$ths per cent. of the purity as possible. Some of these elements reduced the tenacity and extensibility of gold to a very low point, while others increased one or both of these properties. I will now attempt to give an explanation of these facts. Since 1826, when Gmelin called attention to the relations between the atomic weight of elements which have similar properties, chemists have been actively engaged in establishing analogies between the properties of the elements and in arranging them systematically, and the result has been (mainly through the labours of Newlands, Mendeléef, and Lothar Meyer) the promulgation of the Periodic law. This law states that the properties of the elements are a periodic function of their atomic weights. Lothar Meyer has gone further, and has shown that a remarkable relation exists between the atomic volumes of the elements. Now, however tiny the atoms may be, they must possess volume, and the volume of each element will be peculiar to itself. The space occupied by the atomic volume cannot be measured absolutely, but relative measurements may be obtained "by taking such quantities of the elements as are proportional to their atomic weights, and comparing the space occupied by these quantities." The relative atomic volumes of the elements are found by dividing the atomic weights of the elements by their specific gravities. The atomic weight of gold is 196·2; $\frac{196 \cdot 2}{19 \cdot 3} = 10 \cdot 2$ the atomic volume, or, pressed in the metric system, 196·2 grammes of gold would occupy a space of 10·2 cubic centimetres. Lead, on the other hand, would have the large atomic volume of 18·1, and potassium that of 45·1. The question now arises, Does the power to produce fragility, which we have seen certain elements to possess, correspond to any other property of metals with which they may be classified? The facts represented in the Periodic law were in 1869 graphically represented by Lothar Meyer in his well-known curve of the elements. By adopting atomic weights and atomic volumes as co-ordinates, he showed that the elements can be arranged in a curve representing a series of loops, the highest points of which are occupied by cæsium, rubidium, potassium, sodium, and lithium, whilst the metals which are most useful for industrial purposes occupy the lower portions of the several loops.

An examination of the results I have hitherto obtained shows that not a single metal or metalloid which occupies a position at the base of either of the loops of Lothar Meyer's curve diminishes the tenacity of gold. On the other hand the fact is clearly brought out that metals which render gold fragile all occupy high positions on the curve. This would appear to show that there is some relation between the influence exerted by the metallic and other impurities, and either their atomic weights or their atomic volumes. It seems hardly probable that it is due to atomic weight because copper, with an atomic weight of 63·2 has nearly the same influence on the tenacity of pure gold as rhodium, with an atomic weight of 104, or as aluminum, the atomic weight of which is 27·0. It will be evident from the Table on p. 1,132, which embodies the results of my experiments, that metals which diminish the tenacity and extensibility of gold have high atomic volumes, while those which increase these properties have either the same atomic value as gold, or a lower one. Further, silver has the same atomic value as gold, 10·2, and its presence in small quantities has very little influence one way or the other on the tenacity or extensibility of gold.

Several of the elements, the action of which has been examined, occupy somewhat abnormal positions, and the reason for this remains to be explained. I hesitate to attempt to offer any mechanical theory to account for the action of the elements, but it may perhaps be well to refer to these spheres as affording a rough indication of what may take place. If five spheres, representing atoms of a certain volume, are arranged so as to touch each other, it will be evident that the addition of an element with a small atomic volume may improve the tenacity by filling up the central space which would otherwise remain void: with such an arrangement of five atoms the addition of an element with the same atomic volume as themselves will tend to drive them slightly further asunder, and should, therefore, act prejudicially in a five-atom group, although it would exactly fill the space between a six-atom group, but in either case the insertion of

Name of added element.	Tensile strength. Tons per square inch.	Elongation, per cent. (on three inches).	Impurity per cent.	Atomic volume of impurity.
Potassium	Less than 0·5	Not perceptible	Less than 0·2	45·1
Bismuth	0·5 (about)	,,	0·210	20·9
Tellurium	3·88	,,	0·186	20·5
Lead	4·17	4·9	0·240	18·0
Thallium	6·21	8·6	0·193	17·2
Tin	6·21	12·3	0·196	16·2
Antimony	6·0 (about)	qy.	0·203	17·9
Cadmium	6·88	44·0	0·202	12·9
Silver	7·10	33·3	0·200	10·1
Palladium	7·10	32·6	0·205	9·4
Zinc	7·54	28·4	0·205	9·1
Rhodium	7·76	25·0	0·21 (about)	8·4
Manganese	7·99	29·7	0·207	6·8
Indium	7·99	26·5	0·290	15·3
Copper	8·22	43·5	0·193	7·0
Lithium	8·87	21·0	0·201	11·8
Aluminium	8·87	25·5	0·186	10·6

a larger atomic volume than that of each member of the group, must tend to drive the members of either the five or six-atom group further asunder, and by so doing would diminish the cohesion of the mass. No doubt, in some cases, condensation takes place, and this may explain some of the abnormal results.

Questions of great industrial interest present themselves, especially in connection with iron. With regard to this metal, the evidence as to the action of other elements upon it would appear to tend in the same direction, as in the case of gold, although the question is greatly complicated by the relations of iron to oxygen, and by the presence of occluded gases. It may be sufficient for the present to point out that the atomic volume of iron is 7; carbon, the atomic volume of which is small, when present in quantities varying from 0·2 to 1 per cent. improves its tenacity. Silicon, notwithstanding its large atomic volume 11·1, appears to improve the tenacity of iron, although little is as yet known concerning its influence in small quantities. Sulphur and phosphorus, on the other hand, have the large atomic volumes of 15·4 and 14·8 respectively, and both these elements have, as is well known, a highly prejudicial effect on the qualities of iron. Take the case of arsenic, which has an atomic volume of 13·3. One of my own students, Mr. Harbord, has recently read a paper before the Iron and Steel Institute, in which he shows that the effect of the presence of $\frac{2}{10}$ths per cent. of arsenic is very prejudicial to iron.

We do not as yet know what is the effect of manganese on absolutely pure iron, but in the simultaneous presence of carbon its influence is most remarkable. You cannot make a magnet out of iron which contains a certain amount of manganese. Its atomic volume is the same as that of iron, and therefore it ought not to act prejudicially on the tenacity of iron, and I think I am safe in saying that it does not. But with regard to permeability of iron to magnetism, the manganese has a remarkable effect, for, as Dr. Hopkinson tells us, "manganese enters into that which must be regarded for magnetic purposes as the molecule of iron, and annihilates the magnetic properties of iron."* I could have wished for no better evidence as to molecular change in a metal.

Take again the capacity for being hardened by rapid cooling, which is characteristic of steel, and is due to the carbon the metal contains. Here is a knife of soft steel which bends readily; it contains some $\frac{5}{10}$ per cent. of carbon; if it is heated to redness and rapidly cooled it becomes hard. Here is another knife, containing the same amount of carbon; heat it to redness, and cool it rapidly; it is softer than it was originally, instead of being harder. This remarkable material contains manganese in addition to carbon, and the

* "Phil. Trans.," 1885, Part II., p. 462.

manganese has entirely obliterated the action of the carbon. My last illustration is afforded by chromium. The presence of chromium in iron, together with carbon, confers extraordinary hardness upon this metal. A chromium-steel projectile, 12 inches long, fired against the compound armour-plates made by some of our most renowned makers, pierced no less than a 16-inch armour-plate, which it shattered very severely; and conversely, a chilled iron armour-plate containing chromium withstood a one-ton shot from a 17-inch Armstrong gun, propelled by over 8 cwt. of powder, and the shot only made a dent $1\frac{3}{4}$ inch deep, a most extraordinary result, when the enormous power of a ton shot so fired is borne in mind. Chromium has the same atomic volume as iron.

I must not go further this evening. I will only ask you to remember that the knowledge of the kind of facts we have considered comes to us from very early times, for the influence produced on metals by small quantities of added matter had a remarkable effect on the development of chemistry, mainly by sustaining the belief of the early chemists in the possibility of ennobling a base metal so as to transmute it into gold. This was the object to which they devoted life and health, and laboured with fast and vigil. We inherit the results of their labours, and their prayers have been answered in a way they little thought, for, from an industrial point of view if not from a scientific one, metals are transmuted by traces of impurity. Possibly we are nearing an explanation of the causes that are at work, but the fact remains that iron may be changed from a plastic substance, which in ornament can be fashioned into the most dainty lines of flow, into one of great endurance, from which shells and armour-plate may be made. To this material, for the present at least, the defence of the country may be entrusted, apparently because carbon, manganese, and chromium have small atomic volumes.

Miscellaneous.

TEXTILES.*

By William Morris.

There are several ways of ornamenting a woven cloth—(1) real tapestry, (2) carpet weaving, (3) mechanical weaving, (4) printing or painting, and (5) embroidery. There has been no improvement—indeed, as to the main processes, no change—in the manufacture of the wares in all these branches since the 14th century, as far as the wares themselves are concerned. Whatever improvements have been introduced have been purely commercial, and have had to do merely with reducing the cost of production; nay, more, the commercial improvements have on the whole been decidedly injurious to the quality of the wares themselves.

The noblest of the weaving arts is tapestry, in which there is nothing mechanical. It may be looked upon as a mosaic of pieces of colour made up of dyed threads, and is capable of producing wall ornament of any degree of elaboration within the proper limits of duly considered decorative work.

As in all wall decoration, the first thing to be considered in the designing of tapestry is the force, purity, and elegance of the *silhouette* of the objects represented, and nothing vague or indeterminate is admissible. But special excellencies can be expected from it; depth of tone, richness of colour, and exquisite gradation of tints are easily to be obtained in tapestry, and it also demands that crispness and abundance of beautiful detail which was the especial characteristic of fully developed Mediæval art. The style of even the best period of the Renaissance is wholly unfit for tapestry; accordingly we find that tapestry retained its Gothic character longer than any other of the pictorial arts. A comparison of the wall hangings in the Great Hall at Hampton Court with those in the Solar or drawing-room will make this clear to anyone not lacking in artistic perception; and the comparison is all the fairer, as both the Gothic tapestries of the Solar and the post-Gothic hangings of the hall are pre-eminently good of their kinds.

Carpet-weaving is somewhat of the nature of tapestry; it also is wholly unmechanical, but its use as a floor-cloth somewhat degrades it, especially in our northern or western countries, where people come out of the muddy streets into rooms without taking off their shoes. Carpet-weaving undoubtedly arose among peoples living a tent life, and for such a dwelling as a tent, carpets are the best possible ornaments.

Carpets form a mosaic of small squares of worsted, or hair, or silk threads, tied into a coarse canvas, which is made as the work progresses. Owing to the comparative coarseness of the work, the designs should always be very elementary in form, and suggestive merely of forms of leafage, flowers, beasts and birds, &c. The soft gradations of tint to which tapestry lends itself are unfit for carpet-weaving: beauty and variety of colour must be attained by harmonious juxtaposition of tints, bounded by judiciously chosen outlines; and the pattern should lie absolutely flat upon the ground. On the whole, in designing carpets the method of contrast is the best one to employ, and blue and red, quite frankly

* Reprinted, by permission, from the Introduction to the Catalogue of the Exhibition of the Arts and Crafts Society.

used, are the main colours on which the designer should depend.

In making the above remarks I have been thinking only of the genuine or hand-made carpets. The mechanically-made carpets of to-day must be looked upon as make-shifts for cheapness' sake. Of these, the velvet pile and Brussels are simply coarse worsted velvets woven over wires like other velvet, and cut, in the case of the velvet pile; and Kidderminster carpets are stout cloths, in which abundance of warp (a warp to each weft) is used for the sake of wear and tear. The velvet carpets need the same kind of design as to colour and quality as the real carpets, only as the colours are necessarily limited in number, and the pattern must repeat at certain distances, the design should be simpler and smaller than in a real carpet. A Kidderminster carpet calls for a small design in which the different planes, or plies, as they are called, are well interlocked.

Mechanical weaving has to repeat the pattern on the cloth within comparatively narrow limits; the number of colours also is limited in most cases to four or five. In most cloths so woven, therefore, the best plan seems to be to choose a pleasant ground colour, and to superimpose a pattern mainly composed of either a lighter shade of that colour, or a colour in no very strong contrast to the ground; and then, if you are using several colours, to light up this general arrangement either with a more forcible outline, or by spots of stronger colour carefully disposed. Often the lighter shade on the darker suffices, and hardly calls for anything else; some very beautiful cloths are merely damasks, in which the warp and weft are of the same colour, but a different tone is obtained by the figure and the ground being woven with a longer or shorter twill; the tabby being tied by the warp very often, the satin much more rarely. In any case, the patterned webs produced by mechanical weaving, if the ornament is to be effective and worth the doing, require the same Gothic crispness and clearness of detail which has been spoken of before; the geometrical structure of the pattern, which is a necessity in all recurring patterns, should be boldly insisted upon, so as to draw the eye from accidental figures, which the recurrence of the pattern is apt to produce.

The meaningless stripes and spots and other tormentings of the simple twill of the web, which are so common in the woven ornament of the 18th century and in our own times, should be carefully avoided; all these things are the last resource of a jaded invention and a contempt of the simple and fresh beauty that comes of a sympathetic suggestion of natural forms; if the pattern be vigorously and firmly drawn with a true feeling for the beauty of line and *silhouette*, the play of light and shade on the material of the simple twill will give all the necessary variety. I invite my readers to make another comparison; to go to the South Kensington Museum and study the invaluable fragments of the stuffs of the 13th and 14th centuries of Syrian and Sicilian manufacture, or the almost equally beautiful webs of Persian design, which are later in date, but instinct with the purest and best Eastern feeling; they may also note the splendid stuffs produced mostly in Italy in the later Middle Ages, which are unsurpassed for richness and effect of design, and when they have impressed their minds with the productions of this great historic school, let them contrast with them the work of the vile Pompadour period, passing by the early 18th century as a period of transition into corruption. They will then (if, once more, they have real artistic perception) see at once the difference between the results of irrepressible imagination and love of beauty, on the one hand, and, on the other, of restless and weary vacuity of mind, forced by the exigencies of fashion to do something or other to the innocent surface of the cloth in order to distinguish it from other cloths; between the handiwork of the free craftsman doing as he pleased with his work, and the drudgery of the "operative" set to his task by the tradesman competing for the custom of a frivolous public which had forgotten that there was such a thing as art.

The next method of ornamenting cloth is by painting it or printing on it with dyes. As to the painting of cloths with dyes by hand, which is no doubt a very old and widely practised art, it has now quite disappeared; modern society not being rich enough to pay the necessary price for such work; and its place has now been taken by printing by block or cylinder-machine. The remarks made on the design for mechanically woven cloths apply pretty much to these printed stuffs; only in the first place more play of delicate and pretty colour is possible, and more variety of colour also; and in the second, much more use can be made of hatching and dotting, which are obviously suitable to the method of block-printing. In the many-coloured printed cloths frank red and blue are again the mainstays of the colour arrangement; these colours, softened by the paler shades of red, outlined with black, and made more tender by the addition of yellow in small quantities, mostly forming part of brightish greens, make up the colouring of the old Persian prints, which carry the art as far as it can be carried.

It must be added that no textile ornament has suffered so much as cloth-printing from those above-mentioned commercial inventions. A hundred years ago the processes for printing on cloth differed little from those used by the Indians and Persians; and even up to within forty years ago they produced colours that were in themselves good enough, however inartistically they might be used. Then came one of the most wonderful and most useless of the inventions of modern chemistry, that of the dyes made from coal-tar, producing a series of hideous colours, crude, livid, and cheap, which every person of taste loathes, but which, nevertheless, we can by no means get rid of until we are able to struggle successfully against the doom of cheap and nasty which has overtaken us.

Last of the methods of ornamenting comes embroidery; of the design for which it must be said that one of its aims should be the exhibition of beautiful material. Furthermore, it is not worth doing unless it is either very copious and rich, or very delicate, or both. For such an art nothing patchy or scrappy, or half-starved should be done; there is no excuse for doing anything which is not strikingly beautiful; and that more especially as the exuberance of beauty of the work of the East and of Mediæval Europe, and even of the time of the Renaissance, is at hand to reproach us. It may be well here to warn those occupied in embroidery against the feeble imitations of Japanese art which are so disastrously common amongst us. The Japanese are admirable naturalists, wonderfully skilful draughtsmen, deft beyond all others in mere execution of whatever they take in hand; and also great masters of style within certain narrow limitations. But with all this, a Japanese design is absolutely worthless unless it is executed with Japanese skill. In truth, with all their brilliant qualities as handicraftsmen, which have so dazzled us, the Japanese have no architectural, and, therefore, no decorative instinct. Their works of art are isolated and blankly individualistic, and in consequence, unless where they rise, as they sometimes do, to the dignity of a suggestion for a picture (always devoid of human interest), they remain mere wonderful toys, things quite outside the pale of the evolution of art, which, I repeat, cannot be carried on without the architectural sense which connects it with the history of mankind.

To conclude with some general remarks about designing for textiles. The aim should be to combine clearness of form and firmness of structure with the mystery which comes of abundance and richness of detail; and this is easier of attainment in woven goods than in flat painted decoration and paper-hangings, because in the former the stuffs usually hang in folds, and the pattern is broken more or less, while in the latter it is spread out flat against the wall. Do not introduce any lines or objects which cannot be explained by the structure of the pattern; it is just this logical sequence of form, this growth which looks as if, under the circumstances, it could not have been otherwise, which prevents the eye wearying of the repetition of the pattern.

Never introduce any shading for the purpose of making an object look round. Whatever shading you use should be used for explanation only, to show what you mean by such and such a piece of drawing; and even that you had better be sparing of.

Do not be afraid of large patterns; if properly designed they are more restful to the eye than small ones. On the whole, a pattern where the structure is large and the details much broken up is the most useful. Large patterns are not necessarily startling; this comes more of violent relief of the figure from the ground or inharmonious colouring. Beautiful and logical form relieved from the ground by well-managed contrast or gradation, and lying flat on the ground, will never weary the eye. Very small rooms, as well as very large ones, look best ornamented with large patterns, whatever you do with the middling-sized ones.

As final maxims, never forget the material you are working with, and try always to use it for doing what it can do best. If you feel yourself hampered by the material in which you are working instead of being helped by it, you have so far not learned your business, any more than a would-be poet has who complains of the hardship of writing in measure and rhyme. The special limitations of the material should be a pleasure to you, not a hindrance. A designer, therefore, should always thoroughly understand the processes of the special manufacture he is dealing with, or the result will be a mere *tour de force*. On the other hand, it is the pleasure in understanding the capabilities of a special material, and using them for suggesting (not imitating) natural beauty and incident, that gives the *raison d'être* of decorative art.

Correspondence.

FIRE-PROOF TOWNS OF THE RIVER PLATE.

It is curious that, while we have such disastrous and numerous fires in this and neighbouring countries, and in North America, there are modern cities and towns not far off absolutely fire-proof, as Buenos Ayres and Monte Video. Yet it is so easy to make houses fire-proof with wood that many of the architects and builders of Buenos Ayres, and other towns, probably never think they are building fire-proof! They neither use iron nor the arch. As the province is without trees the builders have to use the hard woods from far up the river, which are dear, and so they use little, this being the whole secret.

A hundred walking-sticks may be placed two and a half inches from each other, and yet a fire cannot be made of them if they are spread gridiron-fashion, say across two little walls of brick, and a fire kindled below; it will burn through, say four of the sticks which are in the flames, but there it ends. In the same way, if a waggon-load of shavings and pieces of pine were provided, and half were packed under the best bed in a Buenos Ayres house, and the other half piled over it and set on fire, the bonfire would eventually burn through four or five of the hard wood joists above, and the bricks and tiles of the floor resting on the same would fall through, but there it would end, the house could not be set on fire.

The houses are built as follows, the material being brick:—Each floor and the roof (which is flat) are

supported by joists of hard wood, about the same distance apart as in this country; across these are laid flat rails of the same, and the spaces between these are bridged over by thin bricks thirteen and a half inches long, their ends resting on the rails; another layer of bricks is then laid with lime, and generally on this a layer of flat tiles. The roof is exactly the same, but has a slope of about 1 in 30. Then the doors and windows have no boxes, but simply frames, which are set up on building the walls, and built in. There is no lathing, nor wainscot, nor skirting of the bottom of the walls. And all the wood is of the hard and hardish kinds, slow to ignite. Thus the houses are, as already said, absolutely fire-proof.

The modern houses of Buenos Ayres are very much like those of London, Bath, or Edinburgh, nor would anyone see much difference either outside or in. It would be easy, therefore, to adopt the same way of building here, with the necessary slight modifications. The ends of the joists in the walls would probably decay, in course of time, from external damp penetrating, if they were not of wood indestructible from damp, like in the River Plate towns, where in the experience of the Spaniards, which extends to about two centuries, it does not rot. Hence, if they were only of oak, or, perhaps, teak in this country, a cornice should be built at the top of the walls of each storey, on which the joists should rest besides on half of the wall, and so be sustained if their ends were rotted. The projection stuccoed over would form a cornice, being completed on the other walls, and be ornamental. But this is only necessary for men who would prefer wooden to iron joists. Why not prefer iron, in this the cheapest iron country in the world?

The lathing of the ceilings and walls should be done with iron instead of wood; narrow hoop-iron would do; and the slates be supported by sheet-iron, the drilling of which, and the fixing the slates—perhaps by screws and nuts, could surely be accomplished by our intelligent smiths and slaters. The thick suspended slate would be the best, easily turning to the side when one gets broken.

Lastly, the coldness of the floors could be obviated by their being covered with thin boards of pine, or, better, black poplar, three-quarters of an inch thick, and carpets above; but all the rest of the wood in the house should be of oak or teak, or other hard wood, both hard and wanting in that resin which makes pine so combustible, flying into blazes. Note.—In Buenos Ayres they use carpets in winter, replaced by cool mats in summer; for greater warmth, however, and probably as cheaper, some builders have, latterly, put in pine floors on the hard wood joints instead of bricks and tiles, which is bad policy, and these newer houses are excluded where I state that the city is absolutely fire-proof. But the houses indicated before the above note could not be set on fire by a bonfire made in the best bedroom: but adhering otherwise to the River Plate plan, no boxing nor mouldings of wood around doors and windows, no wainscotting or skirting of wood, but such being done with plaster, stucco, paint, gold, and vermillion, if wished.

Instead of filling our houses with combustible pine, it would surely be better thus to copy the Spanish race in their fire-proof towns, Buenos Ayres, Monte Video, Rosario, Paraná, &c., where no human lives are lost by fire, nor priceless works of art! We not only make combustible private dwellings, but hospitals, infirmaries, lunatic asylums, sailors' homes, and the like, and the inmates are burned alive, or they are nearly killed by the bursting of the cistern on the roof, as in St. George's Hospital not long ago. The great lunatic asylum to the east of Glasgow, only finished a few years ago, was afterwards on fire, and the managing staff at their wits' end with the 400 and odd lunatics within. Theatres, halls, and churches are combustible, exposing us to frightful risks. And the money losses are tremendous; mills, factories, iron works, even in the country where iron is so cheap, are combustible, and are often burned up new in consequence.

And it is totally unnecessary! When the Theatre Royal, of Edinburgh, was burned the last time but one, and the Lord Dean of Guild and others perished at the post of duty by the falling of a wall, and the Surrey Theatre was destroyed the same way about a fortnight after, the *Times* had a leader alluding to both, and saying that a theatre need not have a particle of wood in it but the stage floor. Even this floor, the writer thinks, could easily be of iron, with a thin lining of wood on it.

We have now to learn to build without enough of wood to be capable of conflagration.

Finally, why should we be at the mercy of any madman who, with a penny box of matches, could fire a dozen houses, theatres, infirmaries, or palaces?

THOMAS GIBSON.

General Notes.

COAL IN INDIA.—One hundred and five collieries are now open in India, 69 of which raised 1,388,400 tons of coal in 1886. The imports of coal during the same year amounted to 848,878 tons.

QUICKSILVER IN THE UNITED STATES.—In 1887 the production of quicksilver in the United States increased from 29,981 flasks, valued at 1,060,000 dollars, to 33,825 flasks, valued at 1,429,000 dollars. The price varied in San Francisco from 36·50 dollars to 48 dollars per flask. The total supply came from California, with the exception of 65 flasks from Oregon.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

UNION OF INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Lambeth Polytechnic, Ferndale-road, Clapham, S.W.

Free Library, Wolverhampton.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Professor W. Chandler Roberts-Austen, F.R.S.

Lecture III.—Delivered March* 19, 1888.

Twenty-four years ago the accomplished artist, architect, and antiquary, the late Mr. William Burges, delivered a course of Cantor lectures before the Society of Arts.† He stated that he "had been requested by the Council to show how the arts have formerly been applied to industry; how they are at present applied; and what may possibly be done to increase their application." Mr. Burges dwelt at some length on bronze, brass, gold, and silver, and his lectures, generally, were considered to be so important, that the present Director for Art at South Kensington made them the text for an address delivered before this Society in February, 1887, when he reviewed the progress which has been made during the past thirty years. But you will say the metallurgist cannot speak with authority on themes such as these; I have, however, treated the subject in a manner which will, I believe, enable me to bring before you important truths affecting a wide range of industrial operations, and, at the same time, to sustain the true function of art by pointing to the direction in which we may have increased pleasure in things that constitute our most ordinary possessions, and which we use in daily life. First permit me to explain that I intend to include under the title of the lecture any facts which are, in my opinion, connected with the colours of metals and alloys, whether natural to them, or produced by artifice, as well as a brief examination of the influence which the colours of metals appear to have exerted on the history of science.

I propose to begin at what will appear to be a somewhat remote starting-point. We say that copper is red, gold yellow, and silver white, but it is by no means certain that the early races of the world had any very clear perception of the difference between these several metallic colours. With regard to early Hebrew and Greek civilisation, Mr. Gladstone has expressed his belief that the colour-sense—that is the power of recognising colour and distinguishing it from mere brightness or darkness—was imperfectly developed, and he considers that "the starting-point is absolute blindness to colour in the primitive man," and he urges that the sense of colour has been gradually developed "until it has now become a familiar and unquestioned part of our inheritance." He adds:—"Perhaps one of the most significant relics of the older state of things is to be found in the preference (known to the manufacturing world) of the uncivilised nations for strong and, what is called in the spontaneous poetry of trading phrases, loud colour."*

Dr. Magnus holds the view that the colour-sense in man has undergone a great improvement within the last 2,000 years, and Professor Haeckel supports this speculation. But it is

* This lecture was originally delivered in 1886, to the Operative Classes of Birmingham, in connection with the British Association. It is now published in this *Journal* as modified for delivery before the Society of Arts, in order that it may form part of the series of lectures (delivered by the author) which began, in 1884, with a course of four lectures on "Alloys Used for Coinage."

† "Art Applied to Industry," by W. Burges. 1865.

* *Nineteenth Century*, p. 367, 1877.

opposed by Romanes, who has favoured me with some observations on the subject, in view of this lecture; and it seems to me strange, if savage nations are really deficient in the sense of colour, that the use of such colours as they can get in metals and fabrics, blended, for instance, in a war-club or a pipe-stem, should be so thoroughly "understood" and so discriminately employed as we sometimes find them to be. It may further be observed that primitive man may even have derived from his more remote ancestry some power of being influenced by colour, and we are told that the attraction which gorgeous colouring in flowers has for birds and insects, and which colour generally possessed for our nearer ancestors, has been of great importance in the origin of species, and in the maintenance of organic life.

No doubt in ancient times there was much confusion between mere brightness and colour, such as is evident in the beautiful sentence in which St. Augustine* says:—"For this queen of colours, the light, bathing all which we behold, wherever I am through the day, gliding by me in varied forms, soothes me when engaged on other things and not observing her." If, however, it were proved that the power of distinguishing the colour of metals was not widely diffused among the Egyptians, Hebrews, and Greeks, it is at least certain that there were individuals of these nations to whom, in very early times, the colour of metals was all-important; and although they may have confused different precious stones under generic names, they certainly appreciated their various colours, and knew, moreover, that by fusing sand with the addition of a small quantity of certain minerals they could produce artificial gems of varied tints.

My object in leading you so far back—in discussing what appears to be a very matter-of-fact subject—is to point to the close connection between the early recognition and appreciation of colour in metals or minerals, and the foundation of the science of chemistry.

In early scientific history the seven metals known to the ancients were supposed to be specially connected with the seven principal planets whose names they originally bore, and whose colours were reflected in the metals. Thus gold resembled the sun, silver the moon, while copper borrowed its red tint from the ruddy planet Mars. The belief in the intimate relation between colours and metals, the occult nature of which they shared, was very persistent, and we find a seventeenth-century writer, Sir John Pettus, saying* that "painters" derive "their best and most proper colours from metals, whereof seven are accounted the chief, produced from the seven chief metals, which are influenced by the seven planets." A survival of this feeling is suggested by a modern writer, Leslie, who supposed that "when Newton attempted to reckon up the rays of light decomposed by the prism, and ventured to assign to them the famous number seven, he was apparently influenced by some lurking disposition towards mysticism."†

It would be impossible for me to overrate the importance of the colour of metals in relation to scientific history, for the attempt to produce a metal with the colour and properties of gold involved the most intense devotion to arduous research, sustained by feverish hope, attended by self-deception and elaborate fraud, such as hardly any other object of human desire has developed. It led to despair, to madness, and to death; but finally, through all, alchemy prepared the way for the birth of chemistry, and for the true advancement of science.

In early times, as now, gold was an extremely desirable form of portable property, and its colour was perhaps held to be the most distinctive and remarkable fact about it. I may incidentally observe that the dominant idea of colour in connection with the metallic currency survives in the familiar phrase, "I should like to see the colour of his money," which curiously expresses a desire, tempered by doubt as to its fulfilment. On looking back, we find that, at least from the 3rd to the 17th century, the colour of gold haunted the early experimenters, and induced them to make the strangest sacrifices, even of life itself, in the attempt to imitate, and even actually to produce, the precious metal. Let us see what kind of facts were known within the period I have indicated. In barbaric times, hammered pieces of gold, or gold beaten into thin sheets or plates, were used with coloured stones and coral for personal adornment. The next step was to make gold go further by gilding base metals with it, and, in order to do this, the colour was for the moment sacrificed by combining the gold with quicksilver. This was done at least in the

* "Confessions of St. Augustine." Edition edited by E. B. Pusey, D.D. (p. 211).

* "Treatises on Various Subjects of Natural and Chemical Philosophy."

† "Fleta Minor," 1686, Appendix, "Essay on Metallic Words: Colour."

time of Vitruvius, B.C. 80, heat being used to drive away, as vapour, the quicksilver which had been united to the gold, leaving a thin film of precious metal on the surface to be gilded. But this was possibly not the first method of gilding, for we now know, from a papyrus of about the 3rd century* of our era, that lead was used for this purpose. Gold, when fused with lead, entirely loses its golden colour, and yet, by the application of heat in air, the lead may be made to flow away as a fusible oxide, leaving the precious metal on the metallic object to be gilt, the base metal being as it were transmuted, superficially at least, into gold. The point I want to insist upon is that the metallic colour of the gold vanished during the process as carried on by the craftsman, only to re-appear at the end of the operation; and I am satisfied that it was from such simple technical work as this that the early chemists were led to think that the actual production of gold—the transformation of base metals into gold—was possible. The more observant of them, from Geber, the great Arabian chemist of the 7th century, to our own countryman, Roger Bacon, in the 13th, saw how minute a quantity of certain substances would destroy the red colour of copper, or the yellow colour of gold. A trace of arsenic will cause the red colour of copper to disappear; therefore, the alchemists very generally argued, some small quantity of the right agent, if only they could find it, will turn a base metal to the colour of gold. Look, they said, how small a quantity of quicksilver will change the appearance of metallic tin. Here is a bar of tin two feet long and one inch thick, which it would be most difficult to break, though it will readily bend double. If only I rub a little quicksilver on its surface a remarkable effect will be produced, for the fluid metal will penetrate the solid one,‡ and in a few seconds the bar will, as you see, break readily, the fractured surface being white, like silver. It was by such facts as this that men were led to believe that the white metal, silver, could be made.

Successive workers at different periods held divergent views as to the efficacy of the transmuting agent. Roger Bacon, in the 13th century, held that one part of the precious substance would suffice to turn a million parts of base metal into gold. Basil Valentine, in the 14th century, would have been content with the transmutation of seventy parts of base metal by one part of the agent, while, coming to the end of the 18th century, Dr. J. Price, F.R.S., of Guildford, only claimed that the substance he possessed would transmute from thirty to sixty parts of base metal.*

It is a curious fact that no one seems to have actually prepared the transmuting agent for himself, but to have received it in a mysterious way from "a stranger;" but I must not dwell on this. I will merely point out how persistent was the view as to the singular efficacy of the transmuting agent, and I will content myself with a reference to Robert Boyle, our great countryman, an accurate chemist of the 17th century, who did more than any one else to refute the errors of alchemy. He nevertheless characteristically records the following experiment,† in which, instead of ennobling a base metal, he apparently degraded gold to a base one. He first purified a small quantity of gold, about "two drachms," with great care, and, he states, "I put to it a small quantity of powder communicated to me by a stranger"—it is singular that even he should have received the transmuting agent in the usual way—"and," he adds, "continuing the metal a quarter of an hour on the fire, that the powder might diffuse itself through it . . . . the metal when cold appeared to be a lump of dirty colour . . . . 'twas brittle, and, being worked with a hammer, it flew into several pieces. From hence," he adds, "it appears that an operation almost as strange as that called 'projection'" (or transmutation) "may safely be admitted, since this experiment shows that gold . . . . the least mutable of metals, may in a short time be exceedingly changed . . . . by so small a portion of matter that the powder transmuted a thousand times its weight of gold." He elsewhere observes of a similar experiment, "transmutation is nevertheless real for not being gainful, and it is no small matter to remove the bounds which Nature seems very industriously to have set to the alterations of bodies."‡ The

* "Les Origines de l'Alcheimie," par M. Berthelot, 1885, pp. 82, 89. It is interesting to compare the account of this method of gilding by lead with the expression used by Homer, who says:—"As when gold is *fused* around the silver by an experienced man."—"Odyssey," vi. 232-35, quoted by Schliemann, "Ilios," p. 258, in relation to a gilded knife of copper which he permitted me to analyse in 1878.

† Homberg, "Mém. de l'Acad. Royale des Sciences," 1713 (vol. published 1739), p. 306.

* "An Account of some Experiments on Mercury, Silver and Gold made at Guildford, in the Laboratory of James Price, M.D., F.R.S.," Oxford, 1782.

† "The Philosophical Works of the Hon. Robert Boyle" (Shaw's second edition), 1738, vol. i., p. 78.

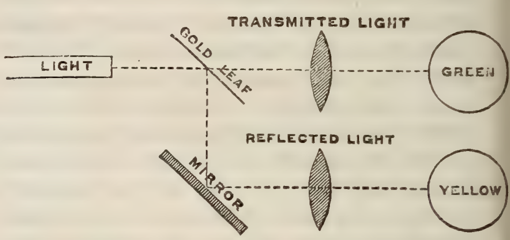
‡ *Loc. cit.*, vol. i, p. 262.

change in the colour of the gold was remarkable, but Boyle had only produced one of the series of alloys most dreaded by every jeweller—"brittle gold"—for the way in which an alloy of gold and copper is affected by a small quantity of impurity presents one of the most serious difficulties in working gold. It has been known since the 7th century, that minute quantities of certain metals change the colour of gold and render it brittle, and it may be well to demonstrate the fact.

Here are two hundred sovereigns; I will melt them, and will add in the form of a tiny shot a minute portion of lead amounting to only the 2000th part of the mass, first, however, pouring a little of the gold into a small ingot, which we can bend and flatten, thus proving to you that it is perfectly soft, ductile, and workable. The rest of the mass we will pour into a bar, and now that it is sufficiently cold to handle, you see that I am able to break it with my fingers, or, at least, with a light tap of a hammer. The colour of the gold is quite altered, and has become orange-brown, and experiments have shown that the tenacity of the metal, that is, the resistance of the gold to being pulled asunder has been reduced from 18 tons per square inch to only 5 tons. These essential changes in the property of the metal have been produced by the addition of a minute quantity of lead. I have cited these facts mainly to show that the changes produced in the colour and properties of metals by small variations of composition were such as to lead the alchemists on in their belief that it was possible to change lead or tin into gold, and the hope in which they worked enabled them to gather facts out of which chemical science was gradually constructed. We shall see presently that changes in the colour of metals and alloys produced by the addition of small quantities of foreign matter are of great importance in the application of metals to artistic purposes, but we must first try to examine more closely some of the prominent facts connected with the colour of metals, that is, the effect metals have on light so as to produce the effect of colour in our eyes. We are apt to think of gold as being essentially and distinctly of golden-yellow; it may, however, possess a wide range of colours without in any way losing the condition of absolute metallic purity, it relations to light depending entirely on the nature of its surface, and especially on whether the metal is in mass or in a more or less fine state of division. Interesting as gold is to us in mass, it is, perhaps, still more interesting to us when beaten so fine that a single grain, of the value of 2d., would cover a space of forty-eight square inches, or when it is so finely divided that the dimensions of a single particle may closely approximate to those of the ultimate atom.

This aspect of the question was investigated by Faraday, and the experimental part of the subject as regards gold remains practically as he left it. It is well known that a leaf of gold when seen by transmitted light is either green or blue, according to its thickness. Here is such a leaf of green gold, as seen when light is actually sent through it (Fig. 1), so as to project a green disc on the screen. A portion

FIG. 1.



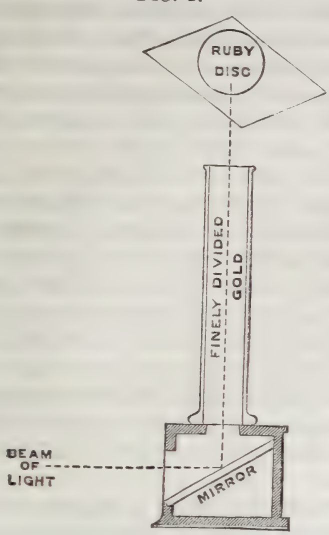
of the light will be reflected from its surface, and this reflected ray may be caught in a mirror and thrown on the screen, so that you have, shown side by side, the green disc of transmitted light, and the golden one of reflected light from the same leaf of gold.

Gold may readily be converted into a soluble chloride which produces a beautiful golden solution. If such a solution contains very little gold, not more than two grains in a gallon, and if certain chemical methods be adopted to precipitate the gold, that is to throw it out of solution in a solid, though in a very fine state of division, the metal may exhibit a wide range of tint, from ruby to black.

[A few drops of phosphorus dissolved in bisulphide of carbon had been added to about a gallon of a very dilute solution of chloride of gold contained in a tall glass cylinder, as shown in the sketch (Fig. 2, p. 1141). The beam from an electric light, thrown through the vessel, revealed in the lower part the presence of finely-divided metal of the natural golden colour, while the more finely-divided gold in suspension imparted a brilliant ruby colour to the liquid, and a glowing ruby disc was projected on a white screen.]

When gold is in the "ruby" state it is so finely divided that each particle probably approximates to the dimensions of the gold atom.

FIG. 2.



[The spectrum was then thrown upon the screen, and the audience was invited to compare it with a diagram which, while closely resembling the solar spectrum, really represented the way in which pure metallic gold, prepared by various methods, is capable of behaving in relation to light so as to possess a wide range of colours.]

It would be easy to show that light is similarly affected by other metals, but I have selected gold for the purpose of illustration because it is easy to maintain it in a state of purity, however finely divided it may be. We must therefore modify any views we may have formed as to a metal having exclusively a special colour of its own, because it will be evident that a particular colour is only due to a definite state of arrangement of its particles. The intimate relation between the state of the surface of a metal and its colour is well shown by the beautiful buttons devised by Sir John Barton. He proved that if very fine lines be drawn close together, so that about 2,000 would be ruled in the space of an inch, a beautiful iridescent effect is produced, the tints being quite independent of the metal itself, due to an optical effect of the lines.

[The image of such a button was then thrown upon the screen.]

Let us now examine some effects of uniting metals by fusing them together into what are called alloys; and, second, the direct influence of a minute quantity of one metal in changing the mass of another in which it is hidden, and causing it to behave in a different way in relation to light, and consequently to possess a colour different from that which is natural to it; or the added metal may so change the chemical nature of the metallic mass that varied effects of colour may be produced by the chemical combinations which result from the action of certain "pickling" solutions. This portion of the subject is so large that I can only hope to set before you certain prominent facts.*

First, with reference to the colour produced by the union of metals. Here is a mass of red copper, and here one of grey antimony; the union of the two by fusion produces a beautiful violet alloy when the proportions are so arranged that there is 51 per cent. of copper and 49 per cent. of antimony in the mixture. This alloy was well known to the early chemists, but, unfortunately, it is brittle and difficult to work, so that its beautiful colour can hardly be utilised in art. The addition of a small quantity of tin to copper hardens it, and converts it, from a physical and mechanical point of view, into a different metal. The addition of zinc and a certain amount of lead to tin and copper confers upon the metal copper the property of receiving, when exposed to the atmosphere, varying shades of deep velvety brown, characteristic of the bronze which has from remote antiquity been used for artistic purposes. But by far the most interesting copper alloys, from the point of view of colour, are those produced by its union with zinc, namely brass. Their preparation demands much care in the selection of the materials, and I might have borrowed from the manufacture of brass instance after instance of the influence of traces of impurity in affecting the properties of the alloy, for I have many inducements in this place to speak about this beautiful alloy. I am proud to be a namesake of the craftsman, William Austen, who, in 1460, made that magnificent monument in brass which covers the remains and commemorates the greatness of Richard Beauchamp, Earl of Warwick, and I am glad to remember that Queen Elizabeth granted the first patent for the manufacture of brass in

* A list of books and papers dealing with the colours of metals and alloys, and with the production of coloured patina, is given by Professor Ledebur in his work "Die Metallverarbeitung," p. 285, 1882, published in Bolley's "Technologie."

England to William Humfrey, Assay Master of the Mint, a predecessor in the office it is my privilege to hold.

I want, however, to direct your attention to-night to some alloys of copper with which you are probably less familiar than with brass. In this direction Japanese art affords a richer source of information than any other. Of the very varied series of alloys the Japanese employ for art metal-work, the following may be considered the most important and typical. The first is called "shaku-do;" it contains, as you will observe from Analyses I. and II.,*

Shaku-do.

I.

Copper	94·50
Silver	1·55
Gold	3·73
Lead	·11
Iron and Arsenic	traces
	99·89

II.

Copper	95·77
Silver	0·08
Gold	4·16
	100·01

in addition to about 95 per cent. of copper, as much as 4 per cent. of gold. It has been used for very large works. Colossal statues are made of it, one cast at Nara in the 7th century being specially remarkable. The quantity of gold is, however, very variable; specimens I have analysed contained only 1·5 per cent. of the precious metal. The next alloy to which I would direct your attention is called "shibu-ichi." There are numerous varieties of it, but in both these alloys, shaku-do and shibu-ichi, the point of interest is that the precious metals are, as it were, sacrificed in order to produce definite results, gold and silver, when used pure, being employed very sparingly to heighten the general effect. In the case of the shaku-do, we shall see presently that the gold appears to enable the metal to receive a beautiful rich purple coat or patina, as it is called, when treated with certain pickling solutions; while shibu-ichi possesses a peculiar silver-grey tint of its own, which, under ordinary atmospheric influences, becomes very beautiful, and to which the Japanese artists are very partial. These are the principal alloys; but there are several varieties of them, as well as combinations of shaku-do and shibu-ichi in various proportions, as, for instance, in the case of kiu-shibu-ichi, the composition of which would correspond to one part of shaku-do rich in gold, and two parts of shibu-ichi rich in silver.

Shibu-ichi.

III.		IV.	
Copper	67·31	Copper	51·10
Silver	32·07	Silver	48·93
Gold	traces	Gold	·12
Iron	·52		
	99·90		100·15

Now as to the action of pickling solutions. Many of you will be familiar with the mysteries of the treatment of brass by "dipping" and "dead dipping," so as to produce certain definite surfaces; but the Japanese art metal-workers are far ahead of their European brothers in the use of such solutions.

The South Kensington Museum contains a very valuable series of 57 oblong plates, some plain and others richly ornamented, which were specially prepared as samples of the various metals and alloys used by the Japanese. The Geological Museum in Jermyn-street has a smaller but very instructive series of 24 plates, presented by an eminent metallurgist, the late Mr. Hochstätter-Godfrey. From descriptions accompanying the latter, and from information I have gathered from certain Japanese artificers now in London, it would appear that there are three solutions generally in use. They are made up respectively in the following proportions, and are used boiling:—

	I.	II.	III.
Verdigris	438 grains	87 grains	220 grains.
Sulphate of copper	292 "	437 "	540 "
Nitre	—	87 "	—
Common salt	—	146 "	—
Sulphur	—	233 "	—
Water	1 gallon	—	1 gallon.
Vinegar	—	1 gallon	5 fluid drachms.

* Analyses Nos. I, and III. are by Mr. Gowland, of the Imperial Japanese Mint at Osaka; Nos. II. and IV. by Prof. Kalischer, "Dingl. Polyt. Journ.," ccxv., 93.

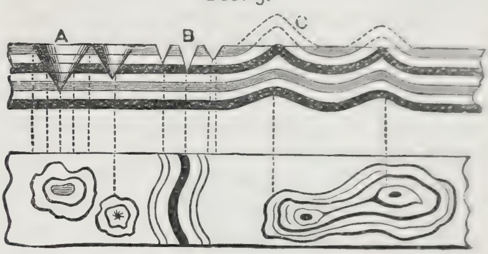
That most widely employed is No. I. When boiled in No. III. solution pure copper will turn a brownish red, and shaku-do, which, you will remember, contains a little gold, becomes purple. And now you will be able to appreciate the effect of small quantities of metallic impurity as affecting the colour resulting from the action of the pickle. Copper containing a small quantity of antimony gives a shade very different from that resulting from the pickling of pure copper. But the copper produced in Japan is often the result of smelting complex ores, and the methods of purification are not so perfectly understood as in the West. The result is that the so-called "antimony" of the Japanese art metal-workers, which is present in the variety of copper called "kuromi," is really a complex mixture containing tin, cobalt, and many other metals, so that a metal-worker has an infinite series of materials at command with which to secure any particular shade; and these are used with much judgment, although the scientific reasons for the adoption of any particular sample may be hidden from him. It is strictly accurate to say that each particular shade of colour is the result of minute quantities of metallic impurity, and these specimens and diagrams will, I trust, make this clear, and will prove that the Japanese arrange true pictures in coloured metals and alloys.

[This portion of the subject was illustrated with much care by coloured diagrams representing specimens of Japanese art metal-work, by photographs projected on the screen, as well as by the reflected images of small ornaments made of the alloys which had been specially referred to. There was also a trophy of large leaves of copper of varying degrees of purity, coloured brilliantly by one or other of the "pickles" above described.]

There is one other art material to the production of which I hope art workmen in this country will soon direct their attention, as its applications are endless. It is called in Japanese "mokumè," which signifies "wood-grain." It is now very rare, even in Japan, but formerly the best specimens appear to have been made in Nagoya by retainers of the Daimio of Owari. I have only seen six examples, and only possess a single specimen of native work, and have therefore had to prepare a few illustrations for you in soldered layers of gold, silver, shibu-ichi, shaku-do, and kuromi.

This diagram (Fig. 3) shows the method of manufacture. Take thin sheets of almost any of the alloys I have mentioned, and solder* them together layer upon layer, care being taken that the metals which will present diversity of colour come together. Then drill conical holes of varying depth, A, in the mass, or devices in trench-like cuts of V section, B, and hammer the mass until the holes disappear; the holes will thus be replaced by banded circles, and the trenches by banded lines. A Japanese artificer taught me to produce similar effects by taking the soldered layers of the alloy, and, by the aid of blunted tools, making depressions on the back of the mass, so as to produce prominences on the front, C. These prominences are filed down

FIG. 3.



until the sheet is again flat; the banded alloys will then appear on the surface in complicated sections, and a very remarkable effect is produced, especially when the colours of the alloys are developed by suitable "pickles." In this way any device may be produced. In principle, the method is the same as that which produces the damascening of a sword-blade or gun-barrel, and depends on the fact that under certain conditions metals behave like viscous solids, and as truly "flow" as pitch or honey does, and in the case of mokumè the art workman has a wide range of tinted metals at command.

Since this lecture was delivered I have succeeded in preparing some elaborate specimens of mokumè, and the artistic merits of the material have been recognised by Mr. Alfred Gilbert, A.R.A., who is employing it in the exquisite *repoussé* metal-work which he alone can produce.

Throughout Japanese art metal-work, in which I hope you will take increasing interest, there is the one principle of extreme simpli-

* The following solder was found to answer well :—

Silver	55·5
Zinc	26·0
Copper	18·5
	100·0

city and absolute fidelity to nature. The brilliant metals, gold and silver, are used most sparingly, only for enrichment, and to heighten the general effect; these precious metals are never allowed to assert themselves unduly, and are only employed where their presence will serve some definite end in relation to the design as a whole. A Japanese proverb asserts that "He who works in gold puts his brains into the melting-pot," meaning, I suppose, that this metal, so precious from an artistic point of view, demands for its successful application the utmost effort of the workman, and suggesting that gold should not be employed in massive forms such as would result from melting and casting, but should be daintily handled, beaten on to the work, or embedded with the hammer.

Bear in mind that in Birmingham, when a really fine work is produced in silver, the surface is often made grey by chemical means, "oxidised," as it is termed, and this subordination of the brilliancy of silver to artistic effect is well understood by the celebrated American firm, Messrs. Tiffany, of New York, who are doing so much to catch the spirit of Japanese art metal-work. All I ask artists to do is to carry this still further—to cover base metals with these glowing coloured oxides, and thus to add to the permanence of art work, by producing surfaces which will resist the unfavourable atmospheric influences of our cities.

The Oriental art metal-workers often blend metals and alloys of different colours by pouring them together at a temperature near the solidifying point of the more infusible of the metals and alloys to be associated. In this way, by pouring the comparatively fusible grey silver-copper alloy on to fused copper which is just at the point of "setting," the metals unite but do not thoroughly mix, and a mottled alloy is produced. The Japanese use such alloys in almost every good piece of metal-work.

The art of complex casting has been practised in India for a thousand years or more, almost exclusively in the Presidency of Madras, as I am informed by Mr. C. Purdon Clarke, C.I.E., to whom I am indebted for the image of Hanuman (Fig. 4), the monkey ally of the god Rama. It was analysed in my laboratory at the School of Mines by Mr. Arthur Wingham. The face, legs, and arms are of rich bronzed copper, while the dress is of yellow brass, the metals being so skilfully blended that no signs of joins or added pieces can be detected. A section cut vertically through the figure revealed the fact that the brass had been cast over a roughly-fashioned solid core of copper, which is less fusible than brass. This investing layer of brass could be readily cut away, and finished so as to leave only the dress and delicate anklets and bracelets on the copper limbs. The method of *cera perduta* was probably used in the production of such castings.

Fig. 4.

a. b.

(*a*) Image of Hanuman in copper and brass. The dark cross lines of the section of the figure (*b*) indicate the relation of the copper core to the investing layer of brass, which is marked with lighter section-lines.

Hitherto we have considered the union of metals by fusion, but fire is not the only agent which can be employed for this purpose. Two or more metals may be deposited side by side by the aid of the electric battery. Birmingham was, as you well know, the early home of electro-metallurgy, an industry to the development of which the great firm of Elkington has so materially contributed. I have no statistics as to the amount of precious metals annually employed for electro-deposition in Birmingham, but it is known that a single works in Paris, belonging to M. Christofle, deposits annually six tons of silver, and it has been estimated that the layer of silver of the thickness actually deposited on various articles would, if spread out continuously, cover an area of 140 acres.* I will not, however, dwell upon the deposition of gold and silver in their normal colours. I would remind you that copper and zinc may be deposited by electrolysis so as to form brass, and that all the beautiful bronzes and alloys of the Japanese can be obtained by galvanic agency; and further, by suitable admixtures of gold, silver, and copper, red gold, rose-coloured gold, or green gold may be deposited, so that the electro-metallurgist has

* H. Bouilhet, "Ann. de Chim. et de Phys.," t. xxiv., p. 549, 1881.

at his command the varied palette of the decorative artist.

[The images of beautiful deposits of coloured gold, specially prepared by Messrs. Elkington, were then produced on the screen.]

I ought to allude to what has been called the moral aspect of colour, and although I cannot follow Goethe* in his attributes of colour, which seem to me to be fantastic and over-strained, I quite recognise the poetic sympathy of Shakespeare in making Bassanio select the casket of lead which contained the warrant for his earthly happiness, because "its paleness moved him more than eloquence." I ask you to remember Ruskin's words, that "all men completely organised and justly tempered enjoy colour; it is meant for the perpetual comfort and delight of the human heart; it is richly bestowed on the highest works of creation, and the eminent sign and seal of perfection in them being associated with life in the human body, with light in the sky, with purity and hardness in the earth; death, night, and pollution of all kinds being colourless."

I must briefly turn to the concluding part of our subject. It has long been known that thin films of certain metals and certain metallic oxides act on light in the same way as thin films of other translucent substances; and since this lecture was originally delivered, at Birmingham, Dr. A. Kundt has published a very interesting paper† to which reference should be made. He has with great care and difficulty prepared sufficiently thin transparent metallic prisms, and by their aid has determined the mean refractive index for seven metals, and for six of them the direction and approximate value of the dispersion. Dr. Kundt has been led to the conclusion that "the velocity of light in the metals stands in close relationship to their power of conducting electricity and heat; for in respect to the velocity of light the metals range themselves in the same order as in respect of their conductivity for electricity and heat." The important generalisation that alloys conduct electricity and heat in the same order I have already referred to in the first lecture.

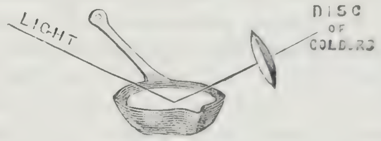
I have here thin films of oxide of lead, which, many years ago, Nobili, Becquerel, and Gassiot taught us to deposit, and such films have since been used in decorative metal-work.

[Carefully prepared examples of such films were projected on the screen.]

I wish I had time to point to the great interest and importance of films of coloured oxide of iron in the tempering of steel, for it is well known that, apart from the scientific interest of the subject, the shades from straw-colour to blue which pass over the surface of hardened steel when it is heated in air, afford precious indications as to the degree of temper the metal has attained, and in no industry is this better shown than in the manufacture of steel pens. I must pass this over, and turn to one other instance of the formation of coloured films on metals.

Here is an ordinary plumber's ladle (Fig. 5)

Fig. 5.



filled with lead, which will soon be molten when it is placed over this flame. The air will play freely on the surface of the melted lead, and, as a certain temperature is reached, very beautiful films will pass over the surface of the metal. If the lead contains very minute quantities of cadmium or antimony, the effect will be greatly heightened. If the light from the electric lamp be allowed to fall on the surface of the bath of lead, it will be easy to throw the image of the metallic surface on the screen, and you will see how beautiful the films are, and how rapidly they succeed each other when the metal is skimmed. What, then, is the special significance of the experiment from our point of view? It represents in a singularly refined way the one experiment which stands out prominently in the whole history of chemistry; for the formation of a coloured scum on lead when heated in air has been appealed to, more than any other fact, in support of particular sets of views, from the time of Geber in the 7th century, to that of Lavoisier in the 18th. It was the increase in weight of the lead when heated in air that so profoundly astonished the early chemists; and finally, the formation of a coloured oxide by heating lead in air was the important step

* Farbenlehrer.

† "Sitzungsberichte der kön. Preuss. Akad. der Wissenschaften," Feb. 16, 1888, and "Phil. Mag.," July, 1888, vol. 26, p. 1.

which led Priestley* to the discovery of oxygen; and Birmingham may claim to have been connected, through him, with one of the most splendid contributions ever offered to chemical science.

I have tried to set before you many of the more important facts which have been deduced from modern researches on alloys, but it has not been possible in this brief course of lectures to deal with the results of the very promising and fruitful thermo-chemical methods of investigation, and which have enabled a distinction to be made between true combinations of metals with each other and mere mixtures or solutions of metals. The following is an outline of the principles by which experimenters have been guided. When a chemical compound is formed, heat is evolved and energy is lost. If, on the other hand, one metal simply dissolves another the solution would be attended with absorption of heat, and the product, when attacked by a suitable reagent, should liberate practically the same amount of heat, but certainly not less than would be evolved by the individual metals present in association. Proceeding on such a basis, Berthelot, whose calorimetric method is well known, examined amalgams of sodium and potassium with mercury.† Troost and Hautefeuille,‡ by attacking carburised iron with chloride of mercury, and measuring the heat liberated, showed that the carbon in cast iron and steel was probably dissolved and not combined, a result of great importance. Recently M. Joannis,§ by decomposing alloys of potassium and sodium by water in a calorimeter, has been led to the conclusion that the alloy Na K_2 is the only one of the potassium-sodium series which is a true compound.

The guidance of the well-known law of Dulong and Petit has been valuable in examining the constitution of alloys, and it has, moreover, long been recognised that the specific heat of alloys approximate to the means of those of their constituent metals. Recently M. Pionchon has shown‖ that the specific heats of alloys of platinum containing 10 per cent. of iridium, and of platinum containing 12 per cent. of palladium, bear out the view that the metals are simply mixed. On the other hand, Pionchon and Le Châtelier* have, independently and by different methods, shown that at a temperature of about 700°C. iron passes into an allotropic state, and Osmond† has further proved that in carburised iron a change in the relation of the carbon and iron takes place during its cooling from a high temperature. The evidence as to molecular change in metals is thus being made very clear, and it is to be hoped that by adopting such methods it will be possible to trace many cases of the passage of alloyed metals into allotropic states.

In this course of lectures my object has been to direct your attention to modern views concerning the constitution of alloys. I have, therefore, hardly touched upon their industrial applications, and have set aside entirely the consideration of the mechanical properties which render them so useful in building and machine construction. You will, I trust, have seen that the scientific importance of alloys is now being recognised, and that they well deserve the most careful study.

* He pointed out that the experiment with minium confirmed his view that the mercury calcined in air derived oxygen from the air.

† *Comptes Rendus*, t. lxxxviii., pp. 1108, 1335, et t. lxxxix., p. 465, 1879.

‡ "Ann. de Chim. et de Phys.," t. ix., 1876, p. 56.

§ *Ibid.*, t. xii., 1887, p. 358.

‖ Pionchon, *Comptus Rendus*, t. cii., pp. 675 et 1454, 1886.

* Le Châtelier, *ibid.*, t. cii., p. 819.

† Osmond, *ibid.*, t. ciii., pp. 743, 1135.

Miscellaneous.

SCENES IN WESTERN INDIA.‡

BOMBAY HARBOUR.

Matharan, and the twin flat-topped Prabal hill, and the remarkable, curiously serrated, saddle-back ridge of Bawa Malang, and the Panala hill, surmounted by the lofty basaltic column which gives it the name of Funnel Hill among Europeans, are the most conspicuous masses, crests, and peaks of the semicircular spur forming the southern watershed of the affluents, from the Malsej, Tal, and Bor *ghats*, of the beautiful Ulhas or Kalyan river, the principal river of the Northern Konkan; a corresponding semicircular spur is the southern watershed of the affluents, from the Bor and Sava *ghats*, of the Amba or Nagotna river, the most sylvan river of the Southern Konkan, and these two curved spurs, converging from the north and south respectively, toward the west, before sinking out of sight, form the bright little archipelago of basaltic islets, which joined together by the clay deposits or the Kalyan and Nagotna rivers, and

‡ From Sir George Birdwood's article in the *Asiatic Quarterly Review* on "The Mahratta Plough."

the little Panvel and Patala-Ganga ["Infernal"—literally, "Patent," *i.e.*, "Wide-mouthed"—"Ganges"] rivers, and by the shells and sand thrown up by the waves of the south-west monsoon, constitute the compound island lying like a natural breakwater in front of the four creeks, and the common estuary, of the Kalyan, Panvel, Patala-Ganga, and Nagotna rivers, and thus forming the magnificent harbour that has given its Portuguese name, and the commercial and naval control of the Indian Ocean, to the palatial city of Bombay;* which rises from its bright green esplanade, flush with the level blue of the Arabian Sea, like the apparition of another Venice, suffused with the rich golden light of the eternal sunshine of the East.

Beautiful indeed, for situation, is Bombay; as well as for providential opportunity the joy and praise of all those whose business is in the salt deep. Among the palm groves tufting the five basaltic monticules and mounds of the surrounding suburbs, sparkle the white walls of the houses of its opulent and luxurious merchant princes; this rare aggregation of natural and artificial features presenting a scene at once splendid, comfortable, and, in its encompassing alpine panorama, wonderful; and absolutely enchanting, when the blaze of day has set, and the silver moon hangs above all in the spacious silence of the clear midnight sky.

"Bombay Point," Mahabaleshwar.

Bombay Point is so-called from its having been there that the plateau of Mahabaleshwar was first reached by the old road from Bombay up the "Rotunda Ghaut."† It is a large space cleared out of a wood of noble evergreen trees, and fenced in, above the Rotunda Pass, by a low parapet, overgrown with *Clematis wightiana* ("murvail"), *Hoya viridiflora* ("hirandori"), the sweet-scented, white-flowered *Jasminum latifolium* ("kusur"), *Embelia basaal* ("ambut"), and other luxuriant creepers and scandent shrubs. The view from it is the most extensive and varied, and the most interesting on the hill; and hence this green, cool, and fragrant spot has become the general resort, of an afternoon, toward sundown, of the English families residing during the "hot season" at Mahabaleshwar. It is evergreen-wooded to its base, in the sweet valley of the Koyna, west of which the rugged, craggy spurs of the Syhadris, stretching across the Konkans, present an infinite diversity of picturesque contours, spur beyond spur, without end toward the north and south, and only bounded on the west by the glittering horizon of the Arabian Sea. It is said that sometimes a glimpse may be obtained beyond the long sylvan valley of the Nagotna River of Bombay, one hundred miles distant; while southward the coast can be followed down to Ratnagiri. In the middle ground the low saddle-backed ridge dipping down from Elphinstone Point, and forming the western enclosure of the Koyna Valley, at its head, suddenly ascends, before dipping down again to the Par* *ghat*, into Sivaji's massive flat-topped hill fort of Pratabgar. Only four miles distant, and rising, by steep grassy slopes, to an altitude of 3,543 feet above the Arabian Sea, distinctly visible on the left, it stands out boldly against the blue sky, directly in front of Bombay Point, and in strong contrast, when, after midday, its whole eastward side is in shade, with the bright, shining heights of the Konkans beyond. As the rays of the afternoon sun begin to strike more and more horizontally through the heated, rarified mists drawn up by it during the forenoon, the natural complexion of this majestic scene undergoes a series of atmospheric transfigurations of indescribable splendour. At first the hills and dales of the Konkans seem to be suddenly transmuted into silver, shining, as with its own light, in dazzling brightness along the ridges of the hills, but with a softer lustre in the dales, where their ethereal illumination is subdued by the lengthening shadows of the sinking sun. In the twinkling of an eye, all is changed to radiant gold, clear as topaz on the hill-tops, with the sea on the left ruled in long levelled lines of chrysolite. And when the day closes upon the eastern hemisphere, the rapidly falling mists pass from a glowing purple to dense indigo, and the cleared sky at last reflects back from the darkened landscape the deep transparent sapphire colour which is the proper tincture of an Indian night.

The Red Silk Cotton Tree.

I shall never forget my first vision of the *Bombax Malabaricum*, or "red silk cotton tree," in the Ram *ghat*. I had left the plain below about 2 a.m., in medical charge of a party of about 250 European troops, and after a slow ascent of some hours, suddenly, at a turn of the road, just at sunrise, came out upon a grassy glade, overhanging the profound forest depths below, at the edge of which stood a colossal specimen of this tree, quite fifty feet high, the trunk straight as "the mast of some great ammiral," deeply buttressed at its base, and sending out horizontal branches, like the yard-arms of a ship, in whorls of five and seven, gradually tapering to the top, and at this season, the month of March, leafless, but covered, in place of green leaves, with huge crimson† flowers, each from five to seven inches in diameter, and forming in the

* The ultimate source of the name of Bombay is the temple of the tutelary goddess Momba-Devi, "Our Lady of Bombay," an auspicious local form of the "Great Goddess" Devi, the consort of Siva.

† That is, *Rortundi-ghat*, "the Roaring (or Crying) Pass," so called from the difficulty of its ascent.

* That is, "the village," *par* or *para* being the Mahratti for "village" or "hamlet," meaning, literally, "altar;" that is, the altar thrown up about the "pipal" (*Ficus religiosa*), or "bur" or banyan tree (*F. indica*), round which every village or hamlet in India is built. *Par-ganah*, a revenue circle of many villages, is literally "the collection (" gang," cf. Gana-pati, "Lord of Hosts") of altars."

† By reflected light deep scarlet, by transmitted, the radiant red of a ruby.

mass a vast dome-like symmetrical head, which, with the beams of the rising sun striking through it, shone in its splendour of celestial, rosy red like a mountain of rubies. I fairly shrieked with delight at the sight of it, and galloped off at once toward it, followed in a rush by the whole column of men, who were mostly recruits, fresh from England like myself, and at last by the young officer in command, who, on taking in the whole situation, which, from where he had stood, in momentary astonishment at so unexpected a breach of discipline, must have been a most picturesque one, with the red coats all swarming over the green grass up to the resplendent tree, and after administering a kindly rebuke to myself, left us to sit on for awhile, worshipping in its ruby-tinted light, before continuing our march to the top of the *ghat*. I could particularise many individual specimen of different gorgeously flowered species of forest trees, such as the golden yellow flowered *Cassia fistula* ("bava"), the purple flowered *Lagestrœmia reginæ* ("taman"), the vermilion and chrome yellow flowered *Butea frondosa* ("pulas"), and the scarlet *Erythrina indica* ("pangri"), which, on account of their stately development, and the striking situations occupied by them at Matharan, Khandala, Mahabaleshwar, and the Ram *ghat*, are each one of them worthy a visit from England.

The Dakhan Plains.

In the fallow interval between February and June, the central plain of the Dakhan assumes, particularly during the sullen stillness of the direct and the reflected solar heat from 11 a.m. to 3 p.m., a scorched and desolated appearance; a yearly recurring memento of the ominious fact that Southern India after all lies within the solstitial, and therefore desert zone of the northern hemisphere; and that only by a wide promotion by the State of scientific forestry, and irrigation works, which should chiefly consist of dams along the natural lines of the trap dykes crossing the rivers, and by assiduous cultivation on the part of the *rayat*, can even the Mahratta country, beyond the immediate shadows of the Syhadris, be made certain of an adequate rainfall and water supply, and secured against famine. But all this is changed, as by some supernatural spell, with the first fearful deafening peals of the burst of the monsoon, and the furious downpour, amid sudden gleams and flashings of lightning, and ceaseless reverberations of thunder, of the divinely odorous and revivifying rain. In a night, as I have known it happen at Kaladgi and Sholapur, the parched earth of the four previous months turns to the tenderest, liveliest green; rivalling in softness of texture, and outvieing in vivacity of hue, the azure of the now refreshened skies outstretched above it. And when the flowers of this, the true Indian spring, begin to appear upon the green expanse, and, trembling like stars in every breath of air that blows across them, first unlock their painted petals, white, red, blue, yellow, and purple, to the day, beholding them, one feels that there is no pleasure under heaven equal to that of looking upon bright, fragrant flowers, fresh blooming in their native fields; and marvellous as is the revelation of the forest vegetation of the Syhadris, the charm is still greater of the enchanting infloresence of the vernal Dakhan plains.

The Chit-Pavan Brahmanis.

The *Chit-pavan* women are of the most refined type of feminine loveliness; and in the sweetness, grace, and dignity of their high-bred beauty, at once modern in its exquisite delicacy, and antique in its fearless freedom, they might well be taken for the Greek originals of the Tanagra "figurines," awaked to a later life among the tropical gardens and orchards and cocoanut groves of the Southern Konkan. One never wearies of watching them, as seen in the dewy mornings in their gardens, perambulating, in archaic worship, the altar of Holy Basil ("tulsi," *Ocymum sanctum*) placed before every Hindu house; or of an afternoon as they pass, in fetching water, to and from the near riverside, or the lotus-laden tank of the village temple, all in flowing robes of cotton, of unbleached white, or dyed a single colour, pink, scarlet, black, green, or primrose yellow; presenting as they move along the red laterite roads in the deepening shadows of the trees, and illumined across the blue sea by the sidelong rays of the declining sun, the richest chromatic effects, with all the bright glamour of a glowing Turner or a Claude. And the outward and visible charms of these fair *Chit-pavnis* do but faithfully mirror the innate virtues of their pure and gentle natures; for they are perfect daughters, wives, and mothers, after the severely disciplined, self-sacrificing, Hindu ideal, the ideal also of Solomon, Sophocles, and St. Paul, remaining modestly at home, as the proper sphere of their duties, unknown beyond their families, and seeking in the happiness of their children their greatest pleasure, and in the reverence of their husbands the amaranthine* crown ("τὸν ἀμαράντινον τῆς δόξης στέφανον") of a woman's truest glory.

General Notes.

Tramways in France.—The total length of tramways open for traffic at the beginning of this year was 450 miles, or only 13 miles more than at the beginning of the previous year. The receipts were £1,397,300, while the working expenses were £1,178,900, leaving a net profit of £218,400. The receipts per mile were £3,109, and the expenses £2,222, the balance to the good being £887. This represents a working expenditure of 84 per cent. on the total receipts, leaving close upon 4 per cent. upon the capital invested in the tramways.

* All down the delectable Malabar Coast the women wear the flowers of the Globe Amaranth *(Gomphrena globosa)*, cultivated in every garden, in their hair. Compare 1 Peter v. 4; and 1 Cor. ix., 25.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE MODERN MICROSCOPE.

By John Mayall, Jun.

Lecture I.—Delivered February, 27, 1888.

Before proceeding with the subject-proper I have engaged to treat of in these lectures, I think it will be *à propos* that I should ask your attention to sundry points of historical interest, which will serve partly to supplement and partly to correct certain data and criticisms made thereon in my previous Cantor Lectures on the Microscope.* The matters I wish to refer to in this connection are generally such as have come to my notice within the last two years only, and this I trust will be considered a sufficient reason for dwelling upon them now.

I formerly stated that there was considerable difficulty in fixing the precise origin of the microscope, both as regards the actual date, and as to the particular form of the construction of the earliest models, but that the date was probably within the two decades comprised between 1590 and 1610.

If, however, we may consider the simple hand-magnifier as a microscope—and there is, I think, a general concurrence of opinion that we are entitled to do so—then I am able to establish the existence of microscopes in the early years of the 16th century by graphic evidence of a specially interesting kind, evidence that appears to have wholly escaped the notice of writers on the microscope hitherto. I refer to the portrait of Pope Leo X., painted by Raphael between 1513 and 1520, which is in the Palazzo Pitti, Florence, and in which the Pope is shown holding a hand-magnifier, evidently intended for the examination of miniatures, &c., in an open volume upon the table. Fig. 1 (p. 1150) is reproduced from an engraving of this portrait.

As it is hardly to be supposed that this hand-magnifier was the first ever constructed, we may infer with some probability that simple microscopes of this form may have been known in the 15th century, or even earlier. The construction of such an instrument would necessarily acquaint the optician with the dependence of the magnifying power on the curvatures of the lens surfaces, which would assuredly lead to the production of lenses of different power for various purposes; so that the evolution of the microscope may have been practically contemporaneous with the construction of the earliest spectacles—may, in fact, have been brought about through the experimental efforts to produce convex spectacle glasses suitable for different sights.

With this anterior evidence before us, demonstrating the existence of hand magnifiers so early, we need no longer perplex ourselves with endeavouring to interpret the vague passages in Fracastoro's "Homocentrica" which certain writers* have cited as evidence that he must have known the use of lenses combined as in telescopes, whilst others† think the matter doubtful.

Galileo's Microscopes.—The very early connection of Galileo's name with the evolution of the microscope is a fact of so much historical

* See *Journal*, vol. xxxiv. (1886), pp. 987-997, 1007-1021, 1031-1048, 1055-1081, and 1095-1121.

* Notably Tiraboschi, "Storia della Letteratura Italiana," Firenze, nuova ed., 1809, vol. vii., pp. 475-6; Ginguené "Histoire Littéraire d'Italie," 2ième ed., Paris, 1824, vol. vii, p. 164; also in his article on Fracastoro in the "Biographie Universelle;" and Libri, "Histoire des Sciences Mathématiques en Italie," Paris, 1840, vol. iii., p. 101.

† In Drinkwater's "Life of Galileo" (Penny Cyclopædia), it is stated that Fracastoro's "expressions, though they seem to refer to actual experiment, yet fall short of the meaning with which it has been attempted to invest them." Fracastoro's knowledge of the employment of lenses is based on the following passage, and another more vague, from his "Homocentrica," sec. ii., cap. 8 (p. 18 of the original edition, Venetiis, 1538, 4to), "per duo specilla ocularia si quis perspiciat altero alteri superposito, maiora multo et propinquiora uidebit omnia," which Drinkwater translates "if anyone looks through two eyeglasses, *one placed upon the other*, he will see everything much larger and nearer." Drinkwater adds: "It should seem that this passage (as Delambre has already remarked) rather refers to the close application of one glass upon another, and it may fairly be doubted whether anything analogous to the composition of the telescope was in the writer's thoughts." Arago, in his "Astronomie populaire" (Paris, 1854, vol. i., pp. 175-6, and Smyth and Grant's translation, London, 1855, vol. i., p. 113), cites the two passages from Fracastoro, and leaves the reader to decide how far they may be fairly taken to prove the possibility of Fracastoro having employed telescopes.

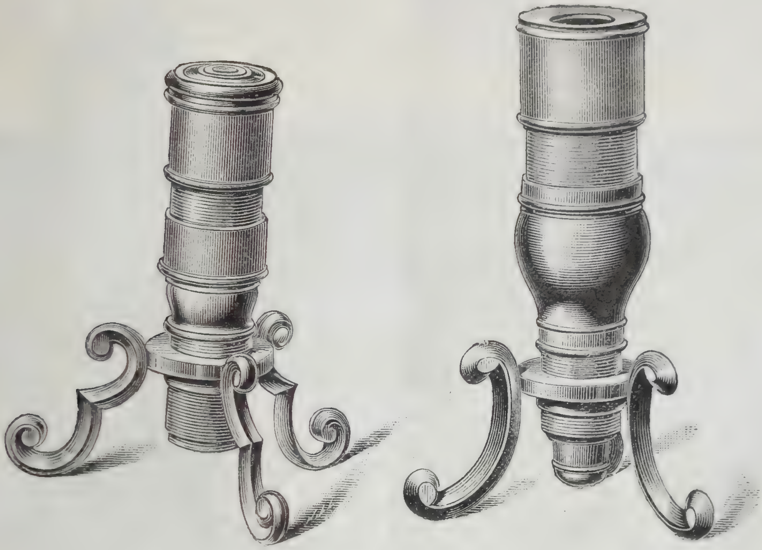
FIG. 1.

POPE LEO X. (FROM AN ENGRAVING OF RAPHAEL'S PAINTING IN THE PALAZZO PITTI, FLORENCE) WITH HAND MAGNIFYING GLASS. (1513—1520).

interest that any instruments bearing traditional association with him must be referred to here.

In the Museo di Fisica, Florence, are two small microscopes, which the Curator, Prof. Meucci, informed me have been handed down from generation to generation, since the dissolution of the famous Accademia del Cimento in 1667, together with other instruments, and with the tradition of being constructed by

FIG 2. FIG. 3.



GALILEO'S MICROSCOPES.

Galileo. By the courtesy of Professor Meucci, I was enabled to secure photographs* of these microscopes, which are here reproduced in Figs. 2 and 3.

When I was permitted to examine these instruments some two years ago, and again about a year ago, I could not evade the suspicion that, if the tradition were critically examined, it might be extremely difficult, if not impossible, to track them to the days of Galileo. The construction of these two microscopes seemed to me so far superior to that of most of the optical instruments made within 20 or 30 years of the death of Galileo (1642), including Galileo's own telescope, that I could not avoid being sceptical as to their alleged origin. I note also the great similarity of design between these microscopes and that of Campani, Fig. 4, which I reproduce from my previous Cantor lectures. This form of Campani's microscope appears to have been first

FIG. 4.

CAMPANI'S MICROSCOPE (1686?).

* At the delivery of this lecture transparencies from the original negatives were projected on the screen by the oxy-hydrogen lantern, which enabled me to point out sundry details of the construction which it has not been possible to show in the woodcuts given herewith.

published in 1686,* and as the original figure has escaped the attention of writers on the microscope hitherto, I here give a photo-zincograph of it (Fig. 5), which will also serve to illustrate what was then considered the proper mode of employing it.

In the matter of construction the advantage is clearly with the "Galileo" microscopes; the tripod, screw-socket, and the body-tube being of substantial metal, the focussing-screw gives a fairly accurate movement, whereas in the Campani instrument the lower portion, though of brass, is very slightly made, and, as the body-tube is of wood, the focussing-screw on the exterior must always have been an inferior arrangement.

I am aware of the difficulties incident to any estimation of the date of these "Galileo" microscopes based merely on what one may consider primitiveness of design, for experience

FIG. 5.

Novum Microscopium Dn: Iosephi Campani, ejusque usus.

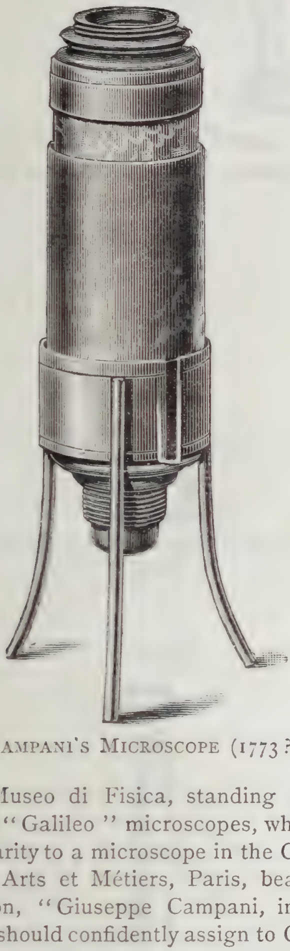
has long informed me that some of the rudest designs have been re-invented over and over again, even in this century. But in these "Galileo" microscopes, neither the design nor the execution appear to me "primitive;" on the contrary, they evince, in my opinion, far too much knowledge of the requirements of microscopes for the date assigned to them *ante* (1642). As the Museo di Fisica contains a large number of optical instruments constructed in the 17th century, comparisons can be readily made, which I did on the two occasions mentioned, and my conclusion was, that these microscopes represent a later date

* "Acta Eruditorum," Tab. x. (pp. 371-2). This date (1686) must cancel my former conjecture as to the possible earlier date of the construction. In the Dresden Museum of Physical Instruments is a microscope of this orm, bearing Campani's name, and the date 1696.

of construction, the design and workmanship being altogether superior to the optical instruments the construction of which dates back to Galileo's time.

By way of illustration of the simplicity of some of the early microscopes, I give a reproduction in Fig. 6 of an instrument

Fig. 6.



Campani's Microscope (1773 ?).

in the Museo di Fisica, standing near the so-called "Galileo" microscopes, which, from its similarity to a microscope in the Conservatoire des Arts et Métiers, Paris, bearing the inscription, "Giuseppe Campani, in Roma, 1673," I should confidently assign to Campani. The "Galileo" microscopes clearly represent a higher grade of mechanical design and construction.

Schott's Microscopes.—I formerly reproduced certain curious figures of microscopes from Gaspar Schott's "Magia Universalis" (1657), expressing myself against the probability of their having ever been constructed as shown. A suggestion has been made by Mr. Frank Crisp, Secretary of the Royal Microscopical Society, by which the anomalous appearance of the instruments may be explained, and as the suggestion appears to me highly probable, I venture to bring it to your notice. To render the matter readily intelligible I reproduce the figures again. (Figs. 7, 8, and 9, p. 1154.)

It is obvious that we estimate the size of the microscopes by comparison with the size of the observer figured with them. Mr. Crisp suggests, then, that the draughtsman, knowing probably nothing of the subject, instead of figuring an eye only directed to the instruments, represented the full-length figure of the observer, whence we estimate the microscopes to be of prodigious size. This explanation is supported by a comparison with Figs. 10, 11, and 12, (p. 1154) from Traber's "Nervus Opticus" (Viennæ Austriæ, 1675, fol., Pl. IV.), in which references are made to Schott's work.

This explanation seems to me the more acceptable from the fact that in describing Divini's microscope (Fig. 9), Schott states that it had a tripod support—"*super tripedale fulcrum*"—which his draughtsman has converted into the fanciful picture of an enormous cylindrical tube, with the observer standing on a sort of embankment to look into it; whereas Traber's figure (my Fig. 12) plainly shows the support, and the instrument appears of reasonable dimensions. Moreover, Schott distinctly states that Fig. 13, p. 1155 (Descartes' lens) was taken from Kircher's "Ars Magna Lucis et Umbræ" (Romæ, 1646, fol.), and on reference to that work we find an eye only directed to the lens (see my Fig. 14, p. 1155, reproduced from Kircher's work); and we note, further, that the insect figured by Kircher on the end of a pointed [rod was converted by Schott's draughtsman into a candle flame!

Hooke's Microscope.—The application of the field-lens to the eye-lens in compound microscopes (described by Hooke in his "Micrographia," 1665) appeared to me the most important item of Hooke's improvements in microscopes; but further research has convinced me that he was preceded by Monconys in this application.

Moncony's Microscope.—In the "Journal des Voyages de Monsieur de Monconys" (Lyon, 1665, 4to, 1ère partie, p. 128) we find a description of his microscope, which I here give in translation:—

Distance from the object to the first lens, *one inch and a-half.*

The focus of the first lens, *one inch.*

Distance from the first lens to the second, *fifteen inches.*

Focus of the second lens, *one inch and a-half.*

Distance from the second to the third, *one inch and eight lines.*

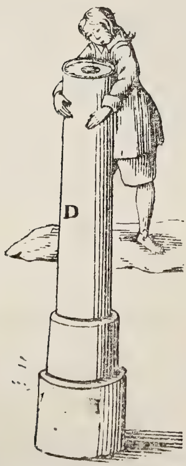
FIG. 7.

MICROSCOPE FROM SCHOTT'S "MAGIA UNIVERSALIS" (1657).

FIG. 8.

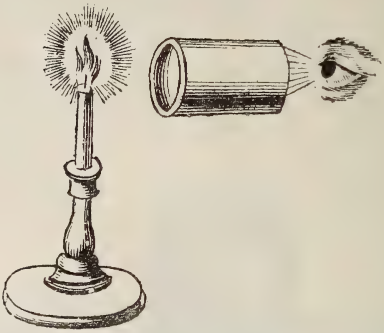
MICROSCOPE FROM SCHOTT'S "MAGIA UNIVERSALIS" (1657).

FIG. 9.



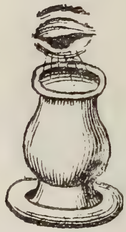
"DIVINI'S" MICROSCOPE, FROM SCHOTT'S "MAGIA UNIVERSALIS" (1657).

FIG. 10.



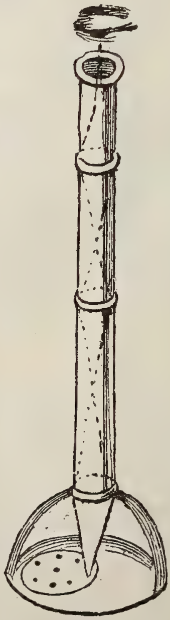
MICROSCOPE FROM TRABER'S "NERVUS OPTICUS" (1675).

FIG. 11.



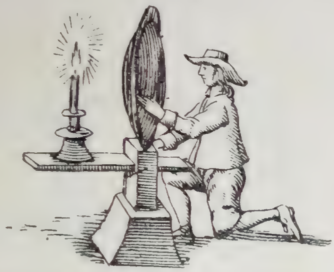
MICROSCOPE FROM TRABER'S "NERVUS OPTICUS" (1675).

FIG. 12.



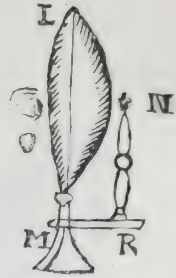
"DIVINI'S" MICROSCOPE, FROM TRABER'S "NERVUS OPTICUS" (1675).

FIG. 13.



DESCARTES' LENS, FROM SCHOTT'S "MAGIA UNIVERSALIS" (1657).

FIG. 14.



DESCARTES' LENS, FROM KIRCHER'S "ARS MAGNA, &C.," (1646).

Focus of the third lens, *one inch and eight lines.*
Distance from the eye to the third lens, *eight lines.*

It is evident that a compound microscope having a field-lens could be constructed from these data. Monconys died in 1664, and from a note on p. 117 (*loc. cit.*) it appears that he had the instrument made, in 1660, by the "son-in-law of Viselius."

In support of Monconys's claim to have first devised a microscope with a field-lens, I may note the testimony of Honorato Fabri, who states in his "Synopsis Optica" (Lugduni, 1667, 4to.), p. 153, that the first instrument known to him of this construction was made at Augsburg to the design of Monconys.

Wherever Monconys travelled he was alert in searching for microscopes and telescopes. In visiting Italy he met Toricelli, Kircher, Divini, and others connected with scientific pursuits, and coming to England in May, 1663, he mentions (*loc. cit.*, *2ème partie*, p. 11) that he visited "Riues en Longenker" (Reeves, of Long-acre), "who makes excellent microscopes," and that a few days later he called again, and was shown a "lanterne sourde" (dark-lantern = "magic-lantern"), having a "hemisphere of crystal of about three inches diameter, which projects to a great distance the images of objects which he places between the light and the crystal lens, by means of a sheet of glass on which they are painted" (*ib.*, pp. 17-18). Other visits to Reeves are mentioned, and on the 3rd of June he called on Boyle and saw "two excellent microscopes, which surpassed his own in size but not in clearness." The next day he again saw Boyle, who explained that in order to examine perfectly the eye of an ox or other animal, he froze it, and then easily cut sections of it, which is the earliest reference I have met with to section-cutting by the freezing process. He mentions also seeing, at Christopher Wren's house in Whitehall, "drawings of a flea . . . . and of a fly's wing made by the microscope."

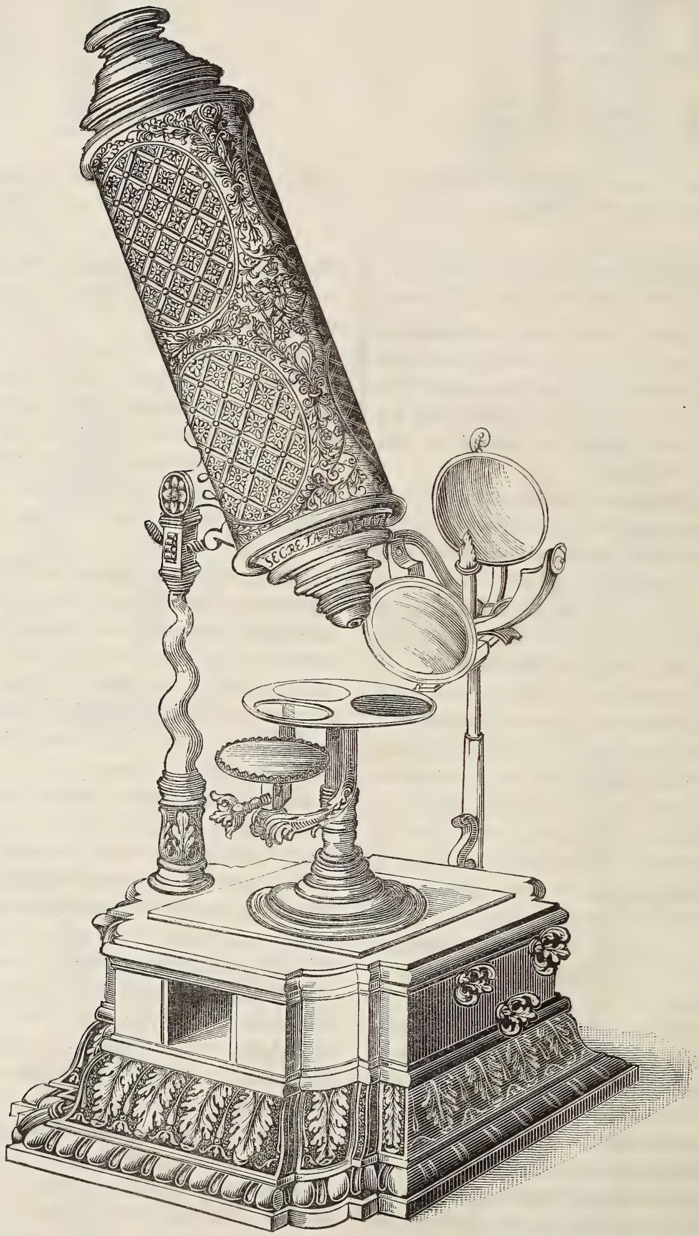
At La Haye, Holland, in August, 1663, he called on Isaac Voss ("Vossius"), and saw his microscope, consisting of "a hemispherical lens mounted in a wood cell, to slide behind a small black tablet, or screen, concaved on the side applied to the eye, and pierced in the middle by a very small hole" (*ib.*, p. 153).

Hertel's Microscope.—The first application of a mirror to the microscope is a point of particular interest in the history of the instrument, and as I have not met with any earlier reference to it than that in Hertel's "*Anweisung zum Glas-Schleifen* (Halle, 1716, sm. 8vo.), Tab. XVIII., I here give a woodcut from his original figure (Fig. 15, p. 1156).

The mirror seems to have been plane ("ein runder plan-spiegel," *loc. cit.*, p. 144). The instrument is otherwise remarkable, (1) for the arrangement of the moveable stage on a special pillar support; (2) for the illuminating arrangement, consisting of a concave metal mirror reflecting the light through a condenser upon the object; (3) for the curious hinge and screw-sector mechanism for inclining the body-tube; and (4) for its generally ornate character, which point probably received attention that would have been more usefully bestowed in making the essential parts of the instrument more substantial.

Lieberkühn's Microscope.—The "Lieberkühn" has become so essential a part of every microscope since its practical development by Dr. N. Lieberkühn, about 1738 (though, as I formerly showed, Descartes had figured an appliance embodying the same principle in his "Dioptrique," published anonymously with his "Discours de la Méthode," in 1637), that the first figure of

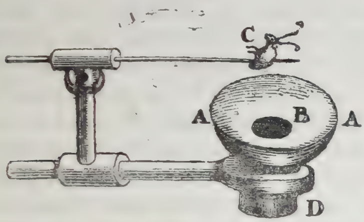
Fig 15.



Hertel's Microscope (1716)).

the device cannot fail to be viewed with interest by every microscopist. Fig. 16 is

FIG. 16.



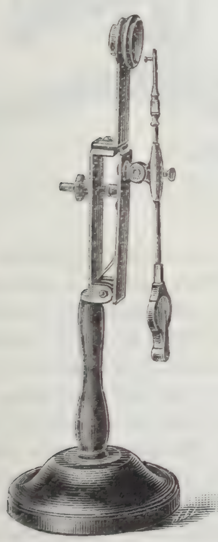
LIEBERKUEHN'S MICROSCOPE (1739).

reproduced from the earliest drawing I have found of Lieberkühn's microscope, in P. Van Musschenbroek's "Essai de Physique,"* tome ii., pl. xviii., fig. 6. The description of the instrument and its employment is thus translated :—

"There has also been recently discovered a good way of strongly illuminating large opaque objects, so that they may be examined by every kind of microscope, even by means of the smallest kinds. AA is a small spherical concave mirror of fine silver, well ground and polished, whence the light is reflected to a focus on the object C, so that it is strongly illuminated at the back. The mirror is pierced in the middle, B, and the microscope [lens or object glass] is then inserted and adjusted either forward or backward: the eye is placed at D, and the object is seen very clearly." (*loc. cit.*, p. 595.)

Fig. 17 is engraved from one of the earliest

FIG. 17.



LIEBERKUEHN'S MICROSCOPE.

* Two vols. 4to., Leyden, 1739.

forms I have met with of Lieberkühn's microscope.

Having disposed of the more important items relating to the early history of the microscope to which I wished to direct your attention, I come to the distinctly modern microscopes. I premise that it would probably be found a convenient arrangement to divide microscopes into two great classes, Ancient and Modern; the former term to include all microscopes made anterior to the general introduction of achromatism ([illegible]), whilst the latter term would designate all microscopes constructed subsequently.

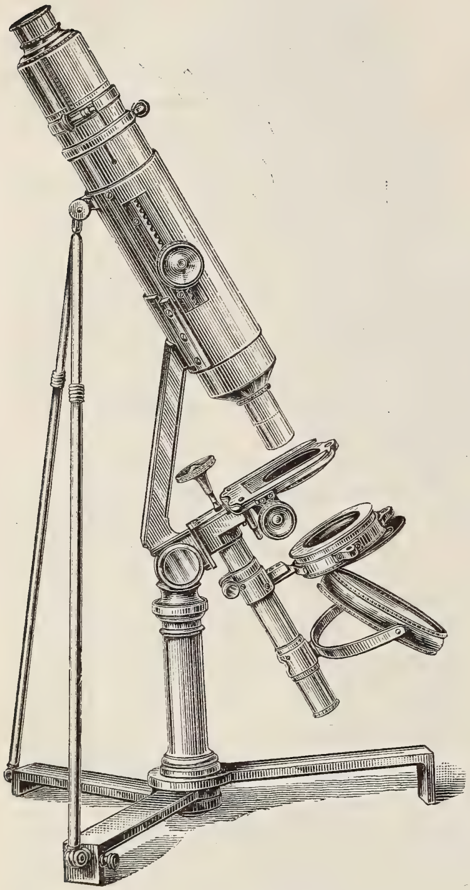
The application of achromatism to the microscope produced great changes in the construction of the instrument. The increase of the apertures of the objectives, involving, as it did, the decrease of the depth of the focal plane, immediately betrayed many imperfections in the design and construction of the focussing arrangements that had previously been either unnoticed or regarded as unimportant.

I formerly gave a figure of the earliest form of achromatic microscope made in France—Selligue's. I am now able to place before you one of the earliest known English models—Tulley's (Fig. 18, p. 1158). The former had no very distinctive claims to originality of design, but was only slightly modified from what was at that period one of the best English microscopes made by Adams, or Jones, or Dollond. In the instruments I have seen bearing Selligue's name, the objectives (and possibly the oculars) were made by Vincent Chevalier (who worked to Selligue's instructions), while the brass-work was made by himself. In the Tulley microscope here shown, struts are applied, connecting the case with the body-tube, the stage has mechanical movements, one movement being lateral in arc, but no special fine-adjustment was applied, probably because the first achromatic objectives made by Tulley were low powers of such moderate apertures that the ordinary rack to the body-tube was found sufficiently sensitive as a focal adjustment. The substage is provided with a rotating disc of graduated diaphragms; the draw-tube is graduated, evidently for the purpose of registering various magnifications, and an erecting combination is applied, whence it would appear that the intention was to work at dissections.

A glance through the instrument shows at once a great increase of light, due to the

achromatic objective, when compared with a single lens object-glass of equal power, for the latter could give a tolerable image only when a very small diaphragm was applied, whereas the former permits the full diameter of the combination to be utilised.

Fig. 18.



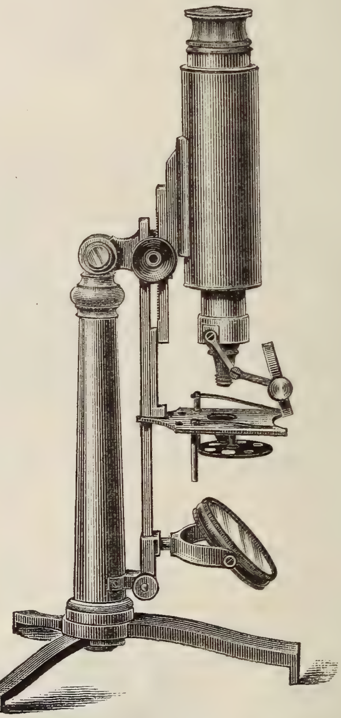
Tulley's Achromatic Microscope.

In further illustration of the early forms of achromatic microscopes I give a figure of one of Charles Chevalier's instruments (Fig. 19)—his influence on the development of the achromatic microscope, as evidenced by the high reputation he acquired by his subsequent invention of the "Microscope Universelle," entitling him to special notice in this connection. The early date of its construction may be inferred from the fact that it is almost exactly similar to Selligue's (1824).

We have here also a revolving disc of graduated diaphragms, which is applied below a truncated conical dark-chamber beneath the stage. The conical dark-chamber in the form of a diaphragm fitting beneath the stage was known and employed early in the last century by Culpeper and others; whilst graduated diaphragms were used with Wilson's "screw-barrel" microscope (1702), and even earlier, as I formerly showed with Musschenbroek's microscope, in which several apertures were cut in a small plate moving in arc across the optic axis of the object-glass.

I am not able to prove that Chevalier was the first to apply the disc of diaphragms to

Fig. 19.



C. Chevalier's Achromatic Microscope.

the microscope, but the method he employed in the application seems to have favourably impressed his contemporaries, for we find that Amici adopted it immediately, and the system has held its ground to the present day, and is still much in vogue for regulating the light, whether used alone, or combined with a condenser. For low-power work the "Iris" diaphragm will probably supersede it; but where extremely delicate changes of light are required, as in critical work with achromatic condensers of high aperture, the perfection of centering obtained with the disc is a great desideratum. The more recent system, the

employment of a diaphragm-carrier pivoting out of the axis, as in Abbe's condenser, by which the range of different apertures can be increased to any extent, is a substantial advance, and has been adopted in the latest form of Powell and Lealand's apochromatic condenser.

Miscellaneous.

BARCELONA EXHIBITION.

By Bennett H. Brough,
Assoc.R.S.M., F.G.S., F.I.C.

A general report on the Barcelona Exhibition, by the Secretary of the Society, appeared in the *Journal* of October 12th. This I have been asked to supplement with some notes on the mining exhibits, which are amongst the most interesting and important of those in the exhibition.

Among the mining countries of the world, Spain occupies a prominent position. At the present time it is the chief producer of quicksilver, and until quite recently was also the chief producer of lead; the copper mines of Huelva are the most important in Europe; the iron mines of Bilbao are celebrated for the quantity of the ores, and for the quality of the metal produced from them; its coalfields are extensive, and ores of zinc and of other metals occur in great abundance. It was, therefore, to be expected that in a Spanish exhibition the exhibits relating to mining would be of the greatest interest, and at Barcelona they justly occupy a prominent position.

Thanks to the aid of the Spanish Government, with its corps of trained mining engineers, the rich mineral resources of the kingdom are fully shown. It is therefore possible for attention to be directed to those deposits that await further development, and that promise to open up a lucrative field for foreign capital. Indeed, this field seems to be inexhaustible, for although Spanish mining is so ancient as to have been carried on by the Romans, fresh discoveries of workable deposits are of frequent occurrence. The great antiquity of Spanish mining is well shown by the interesting collection of archæological objects found in the Rio Tinto mines. From there, too, has been brought a Roman mine-door in excellent preservation, whilst another, equally well preserved, is shown from the San Jose mine at Mazarron. An interesting prehistoric object is a human skull impregnated with carbonate of copper, found in the El Milagro mine at Onis.

The geological structure of Spain is clearly elucidated by the exhibit of the Geological Survey, who show, arranged in stratigraphical order, an exhaustive collection of Spanish rocks and fossils, as well as a collection of all the geological maps of Spain yet published. The National Corps of Mining Engineers exhibit specimens of Spanish minerals and ores from almost every known locality, admirably arranged according to the mining districts. Altogether there are 3,000 specimens, supplemented by 100 plans and photographs. This exhibit forms one of the most instructive mineralogical collections ever brought together, and gives a good picture of the mineral wealth of a country naturally very rich, and now rapidly developing under the influence of improved means of communication. Among the specimens from the Barcelona mining district, a prominent place is given to some splendid specimens of rock-salt of various colours from the Cardona mine, an absolute mountain of salt, some 500 feet in height, and three miles in circumference. A collection of minerals of scientific, rather than economic, interest is shown by the Madrid School of Mines. It numbers 442 specimens, including many of great rarity. The school also shows a collection of 95 specimens of marble, another of Spanish mining and metallurgical tools, and, lastly, a number of interesting models, including one of the winding engines of the Magdalena pit of the Villanueva del Rio Colliery, and another of the machinery for transporting and shipping iron ore employed by the Orconera Company at Bilbao.

The installation of the Almaden mines in the central nave of the Palace of Industry enables an accurate idea to be formed of the present state of these wonderful mines, where the lode sometimes attains a thickness of ten yards, and where no diminution of richness threatens the duration of the workings. Three collections, one of minerals including huge masses of solid cinnabar, one of rocks, and one of metallurgical specimens, serve to explain the nature of the occurrence of the ore and its metallurgical treatment, whilst numerous plans and photographs enable all the operations to be thoroughly understood. Two wooden models represent, on a scale of 1-25th, a pair

of the well-known Almaden aludel furnaces. These have recently been supplemented by condensing-chamber furnaces, two of which are shown by models 1-10th of the true size, a scale unnecessarily large for the purpose. In these new furnaces, the products of combustion and of the decomposition of the ore are caused to traverse in a zig-zag manner a distance of 50 yards through brick chambers, and then through chambers of wood and glass for another 50 yards, finally passing to the chimney at a temperature of 1° to 3° Centigrade above that of the air. Two of these cost £2,200, and in 24 hours treat 14 to 15 tons of ore, producing 30 flasks of quicksilver, at a cost of 2s. 6d. to 3s. 4d. per flask. The Almaden mines are worked by the Government. In the year 1564, they produced 4,000 tons of quicksilver, and the production has since then steadily increased, until in 1887 it amounted to 51,000 tons. In the Mining Court an interesting model of a new type of furnace for treating quicksilver ores is shown by Mr. H. Berrens. The furnace, which is on wheels, is furnished with automatic condensers, and may be moved along rails of the ordinary gauge. No details, however, are given of results obtained in practice.

The Spanish coal-fields are stated to cover an area of 3,500 square miles, the quantity of available coal being estimated at 3,500,000,000 tons, of which at least two-thirds can be mined with profit. It is, therefore, very difficult to account for the inadequate prosecution of coal mining in the Peninsula. The production of coal in Spain in 1885 amounted to 919,440 tons. Half this output was obtained from the important coal-field of the Asturias, on the northern coast. This coal-field possesses 50 distinct workable seams, varying in thickness from 16 inches to 6 feet. As might be expected, therefore, the produce of this field takes precedence among the exhibits of coal, the first place being undoubtedly occupied by the collection of coal shown in various parts of the Exhibition by the Marquis of Comillas from his collieries at Aller. The most striking of his exhibits is a lighthhouse that has been erected in the grounds, built entirely of briquettes made from Aller coal. The original intention was to have illuminated it with the electric light, but as it was situated in such close proximity to the sea-shore, fears were entertained that it might be misleading to mariners. Within the building devoted to the mining exhibits, the Aller collieries again figure with a well-arranged collection of coals and mine-plans, as well as with a detailed table of the analysis and classification of coal, carefully drawn up by the director of the mines, Don Felix Parent. In the park gardens, facing the mining section, the Aller coal has been again utilised in the construction of a very effective trophy representing a double colliery roadway of the usual dimensions, surmounted by a mass of briquettes and three colliery trucks full of coal.

In a separate pavilion, the Andalucian Railway Company exhibit some excellent samples of coal from their collieries at Belmez and Espiel in the province of Cordova. Coke made at the Cabeza de Vaca colliery gave, on analysis, 9·8 per cent. of ash, and was found to have a calorific power of 7,020 calories. Briquettes made at the same colliery had a calorific power of 7,532 calories. At this colliery, and at the company's Santa Elisa colliery, at surface and underground, 1,065 workmen are employed. Both collieries are well equipped with machinery, the Santa Elisa colliery possessing a 500 horse-power winding engine. Among other exhibits of coal in various parts of the exhibition, good samples are shown from Orbó and Barruelo in the province of Palencia, from Quirós in that of Oviedo, from Sabero in that of León, and from San Juan de las Abadesas in Upper Catalonia. Spain also possesses numerous deposits of lignite, in the neocomian strata at Montalban, in Teruel, and in miocene strata at Alcoy, in Valencia, and at Lerida, in Catalonia. Of lignite, in 1885, in Spain 26,464 tons were produced.

The Bilbao iron ores are well shown in the Government collections, and a good idea of the Bilbao iron industry may be formed from the exhibits of iron ores, iron and steel, plans and photographs, shown by the Vizcaya Company, by the Santa Ana Company of Bolueta, and by the Sociedad de altos hornos. The establishment of the last-named company, which affords employment to 1,300 workmen, is the only one where Bessemer and open-hearth steel is made. The stand of the Santa Ana Company is noticeable for the good show of statuary and other artistic castings.

Spain furnishes nearly a third of the world's production of lead. The deposits are extremely numerous, and the ore is of exceptional purity. A specimen of lead ore from the Nuestra Señora del Carmen mine, at Montornes, exhibited by the proprietress of the mine, is stated to contain 84 per cent. of lead, and 3½ oz. of silver to the ton. Some

fine samples of lead are shown from the works of the Marquis of Villemeyor, where the daily output is 100 tons, and from the lead works of the Royal Asturian Mining Company. The production of the latter works during the year 1887 included 6,500 tons of pig-lead, 16,300 tons of zinc ingots, and 11,000 lbs. of fine silver. The Marquis of Villemeyor also shows a glittering mass of fine silver weighing 370lbs.

There are several imposing exhibits of sulphur, a mineral that easily lends itself to decorative treatment, the most striking being those of Molina and Co., of Almeria, and of the Sociedad Minero-industrial of Carretera de Granada. There are several exhibits of Spanish asphalte and building stones, and artificial marbles are well represented. Three tablets of noble serpentine from the San Juan Quarries in the Sierra Nevada (Granada), are of great beauty. The mining section is largely occupied with exhibits of mineral waters, the most notable being those of Rubinat, Ledesma, and Cabestany.

Many of the Spanish mineral exhibits are contributed by persons who cannot possibly derive any pecuniary gain from the Exhibition, and who have incurred expense from a patriotic desire to add to the value of the national portion of the Exhibition.

Foreign mining and metallurgy are very imperfectly represented. Some coals and patent fuels are shown by British colliery companies, and the French and Belgian steel-works have very creditable exhibits; that of chrome steel from the works of M. Jacob Holzer, at Unieux, is particularly fine. The stand, which is built of jasper from his quarries, contains an interesting collection of chrome steel projectiles, varying from 2½ to 16½ inches in diameter. In each case results of firing tests are appended. The 16½-inch projectile, for example, was fired at a 19·69-inch Creuzot steel plate and remained entire. Projectiles are also included in the extensive exhibit of the Ferminy steelworks, Loire. A 16½-inch chrome steel projectile, made at these works, weighing 1,675 lbs., when subjected to a firing test, passed through a 21·66-inch steel plate.

In the French Section Mr. G. A Godillot exhibits a new type of furnace for heating boilers, specially adapted for burning refuse materials hitherto considered worthless. The fuel is supplied through a hopper on the top of the furnace, and is conducted by means of an endless screw to the apex of a grate in the shape of a half cone. The supply of fuel can easily be regulated. During its gradual descent down the cone the fuel is dried, heated, and burned. It finally reaches the horizontal grate, which has the shape of a horse-shoe, and here the combustion is completed, the ashes being easily withdrawn. Excellent results have been obtained with such fuels as tan-yard refuse containing [illegible] per cent. of moisture, chips from dye-works with 60 per cent. of moisture, and dried sawdust and shavings.

Barcelona has always been the pioneer in introducing the great improvements into Spain. Here, in 1818, the first service of stage-coaches was established; in 1836 was launched the first steamboat; in 1833 steam was first used in a factory as motive power; and in 1848 the first railway was constructed. It possessed the first iron foundry, and was the first Spanish town to be lighted by gas and by electricity. And this sketch of the more important mineral exhibits will, it is hoped, show that the mining section at least is well worthy of a city that has had sufficient enterprise to organise the first international exhibition held in Spain.

Correspondence.

CANES AND STICKS.

In the list of canes and sticks by Mr. Jackson, I observe no mention of the hickory stick (belonging to the genus Carya), one of the hardest, though lightest of woods, and indigenous to North America, from which country I brought two fine specimens last year. Their strength and lightness make them a very desirable companion to the pedestrian.

W. A. SATCHELL.

Rosslyn-gardens, Hampstead.

Mr. Jackson writes, in answer to the above letter, that his list was not exhaustive, and was not intended to include all the woods that might occasionally be used. He adds that Messrs. Howell inform him that hickory is not included in their catalogue of raw sticks, because a good appearance is of primary importance, and the hickory has nothing to commend it but the qualities of lightness and strength.

General Notes.

BARCELONA EXHIBITION.—A correspondent who has gone out to visit the Exhibition, writes from Barcelona that the town is thronged with visitors attracted by the Exhibition, which is now complete. The writer thinks that English manufacturers would,

by visiting Barcelona at this time, have an excellent opportunity of seeing what is being done in the south-west of Europe, and could ascertain if there were any probability of their goods finding a market. Up to the present time, he says, the French have almost had a monopoly of the trade of Spain, and he thinks that English manufacturers have lost an excellent opportnnity by not exhibiting more extensively at the Barcelona Exhibition, having regard to the fact that, under the new treaty of commerce, England is now on the footing of the most favoured nation, and there is consequently an admirable opportunity for the introduction of British manufactures into Spain.

Paris Exhibition.—Part of the buildings of next year's Exhibition are to be devoted to a Retrospective Exhibition, intended to indicate the progress which has been made by mankind in various branches of industry. An important division of this section of the Exhibition will be devoted to means of transport, greater prominence being given to this on account of the fact that the International Railway Congress will hold its annual meeting in Paris next year. To carry out the organisation of this section a special committee has been formed, with Lord Brassey as chairman, and Mr. A. Sire, the agent of the Northern Railway of France, as honorary secretary. This committee will co-operate both with the French committee in Paris and with the general committee of the British Section, of which the Lord Mayor is president. The main object of the committee will be to collect and transmit to Paris illustrations of the various appliances employed for locomotion, by water, railway, road, &c. All the exhibits must be of a date anterior to the last Paris Exhibition in 1878. Original objects, models, drawings, and photographs are all admissible. Mr. Sire, the hon. secretary of the committee, will be glad to hear from any persons willing to lend suitable exhibits, especially original objects bearing on the early history of steam navigation, or the origin of railways.

Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have issued a list of subjects on which they invite original communications. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose, the particulars of which are as under:—1. The Telford Fund, left "in trust, the interest to be expended in annual premiums, under the direction of the Council." This bequest (with accumulation of dividends) produces £260 annually. 2. The Manby Donation, of the value of about £10 a year, given "to form a fund for an annual premium or premiums for papers read at the meetings." 3. The Miller Fund, bequeathed by the testator "for the purpose of forming a fund for providing premiums or prizes for the students of the said Institution, upon the principle of the 'Telford Fund.'" This fund (with accumulations of dividends) realises £150 per annum. Out of this fund the Council has established a scholarship—called "The Miller Scholarship of the Institution of Civil Engineers"—and is prepared to award one such scholarship, not exceeding £40 in value, each year, and tenable for three years. 4. The Howard Bequest, directed by the testator to be applied "for the purpose of presenting periodically a prize or medal to the author of a treatise on any of the uses or properties of iron, or to the inventor of some new and valuable process relating thereto, such author or inventor being a member, graduate, or associate of the said Institution." The annual income amounts to nearly £16. It has been arranged to award this prize every five years from 1877. The next award will be made in 1892.

Franklin Institute Medals.—A communication addressed to the Council of the Society of Arts has been received from the Franklin Institute, Philadelphia, containing the following particulars respecting medals for meritorious discoveries and inventions which tend to the progress of the arts and manufactures, at the disposal of the Institute:—1. The Elliott Cresson Medal (Gold).—This award was founded by the legacy of Elliott Cresson, of Philadelphia, and conveyed to trustees of the Franklin Institute. By the Act of the Institution, May 17, 1849, the Committee on Science and the Arts was designated and empowered to award this medal, and the committee decided to grant it, after proper investigation and report by sub-committee, either for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship. 2. The John Scott Legacy Premium and Medal (20 dollars and a medal of copper).—The John Scott legacy premium and medal was founded in 1816 by John Scott, a merchant of Edinburgh, Scotland, who bequeathed to the City of Philadelphia a considerable sum of money, the interest of which should be devoted to rewarding ingenious men and women who make useful inventions. The premium is not to exceed 20 dollars, and the medal is to be of copper, and inscribed "To the most deserving." The Institute request that these particulars may be made known, and on application being made to the secretary of the Franklin Institute, full information will be sent respecting the manner of making application for the investigation of inventions and discoveries. Furthermore, the Committee on Science and the Arts will receive and give respectful consideration to reports upon discoveries and inventions which may be sent to it with the view of receiving one or the other of the awards herein named, and full directions as to the manner and form in which such communications should properly be made will be sent on application.

Journal of the Society of Arts.

No. 1,877. Vol. XXXVI.

FRIDAY, NOVEMBER 9, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PHONOGRAPH AND GRAPHOPHONE.

As it is probable that a large number of members will desire to hear Colonel Gouraud's paper on the "Phonograph," on November 28th, and that by Mr. Edmunds, on the "Graphophone," on December 5th, special arrangements will be made for the convenience of members who wish to be present. The usual rules for the admission of members and their friends will be suspended on these evenings. Admission will be by ticket only, and no person, whether a member or not, can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued for each meeting, to members, in the order in which they apply, until the number is exhausted. Each ticket will admit one person, and is transferable. Each member can have two tickets; either two tickets for either meeting, or one ticket for each of the two meetings.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-fifth Session of the Society will be held on Wednesday, the 21st November, when the Opening Address will be delivered by The Duke of Abercorn, C.B., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 28.—"The Phonograph." By Col. Gouraud.

December 5.—"The Graphophone." By Henry Edmunds.

December 12.—"Explosives." By W. H. Deering, F.C.S.

December 19.—"Standards of Light." By W. J. Dibdin, F.I.C., F.C.S.

Papers for which no dates have as yet been fixed:—

"Manufacture of Sèvres Porcelain." By Edouard Garnier (Director of the Sèvres Manufactory).

"The Forth Bridge." By Benjamin Baker, M.Inst.C.E.

"The Channel Tunnel." By Colonel Hozier.

"Salt." By Peter Lund Simmonds.

"The Construction of Photographic Lenses." By Conrad Beck.

"The Manufacture of Aluminium." By William Anderson, M.Inst.C.E.

"Automatic Selling Machines." By J. G. Lorrain.

"Secondary Batteries." By W. H. Preece, F.R.S.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 29; February 19; March 12; April 2, 30; May 21.

Indian Section.

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November 26; December 3, 10, 17.

Alan S. Cole, "Egyptian Tapestry." Two Lectures.
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Two Juvenile Lectures, entitled "How Chemists Work—an example to Boys and Girls," by HENRY E. ARMSTRONG, Ph.D., F.R.S., will be given on Wednesday evenings, January 2 and 9, 1889, at Seven o'clock.

Proceedings of the Society.

CANTOR LECTURES.

THE MODERN MICROSCOPE.

BY JOHN MAYALL, JUN.

Lecture II.—Delivered March 5, 1888.

It would demand far more time than is placed at my disposal were I to endeavour to illustrate fully the immense variety of modifications in the mechanical and optical construction of the microscope made since the application of achromatism. I must, therefore, limit myself to a rapid outline of those points which have seemed to me most essential.

In the mechanism of the achromatic microscope, no part has had more serious attention, from those who have sought to improve the instrument, than the fine-adjustment. I quite agree with those microscopists who have said that the crucial point of excellence in the highest class of microscope is the fine-adjustment. No elaboration of variety of movements, no monumental solidity of general form, will avail, unless combined with a good fine-adjustment. No microscope should be considered as ranking in the first class unless the fine-adjustment bears critical testing.

In estimating the merits of the vast series of microscopes of different designs constructed since the application of achromatism, allowance must be made for the fact that in the early days the mechanism—in England, at least—was decidedly in advance of the optical construction, so that during nearly thirty years—or up to about the year 1850—what we should now term critical testing was hardly possible. A great number of microscopes, however, were produced, by Pritchard, Smith (afterwards Smith and Beck), Andrew Ross, and Hugh Powell (afterwards Powell and Lealand), previous to 1850, that were more than equal to any contemporaneous microscopy required of them.

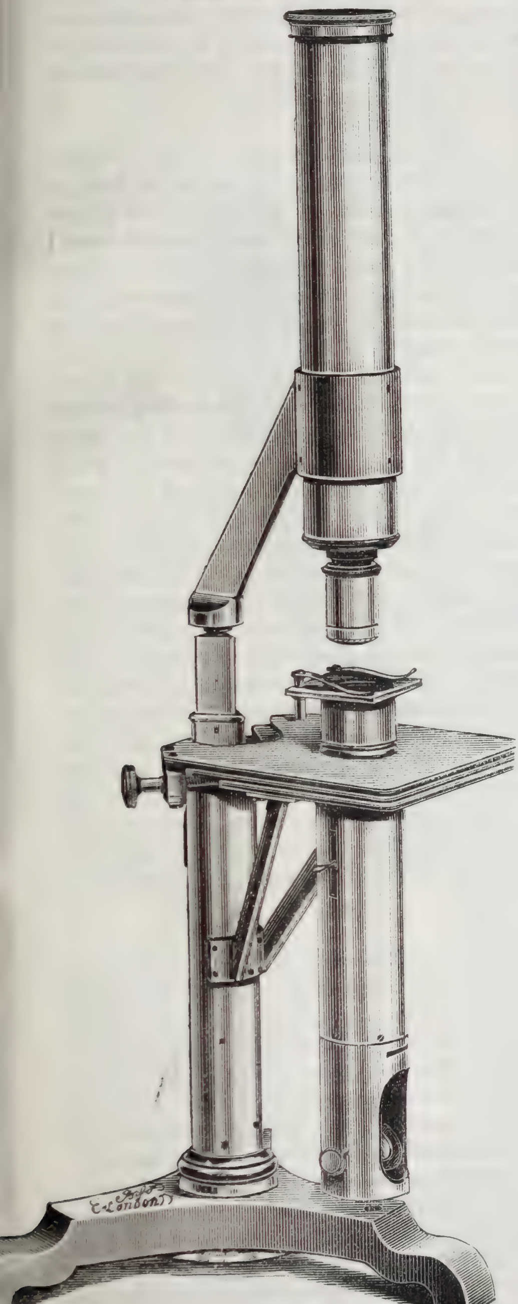
Of Pritchard's share in perfecting the microscope I cannot speak favourably. Beyond aiming generally at supplying good average workmanship, with a strong tendency in favour of mechanism by which the microscope could be raised or lowered, or turned about in very puzzling directions, with clamping screw-collars that seem designed to baffle the ingenuity of the microscopist by the complexity of their action; or, again, in the application of candle-holders with eye-shades, and condensers with single, double, or triple arms, plaster mirrors, bottle holders, &c., &c., most of which movements and appliances served no practical purpose beyond making the instrument more costly, I am not aware that he is entitled to much credit for originality. He was, however, one of the first opticians in England to recognise the merits of C. Chevalier's early achromatic object-glasses, with which he furnished many of the microscopes bearing his own name.

Pritchard's name was so intimately associated with that of Dr. Goring, the inventor of the "Operative Aplanatic Engiscope," that this seems a fitting occasion to mention the instrument, which was elaborately figured in their joint production entitled "Microscopic Illustrations" (London, 1838, 8vo.). It may be briefly described as a large microscope, not differing essentially from many constructed during the previous forty years by Adams, Dollond, or Jones; but instead of the usual inclining-hinge or cradle-joint, Goring applied a ball-joint on the top of the pillar, by which he combined in one piece of mechanism a variety of movements which Pritchard previously obtained in a more complex manner. In the ball-joint Goring was clearly preceded by B. Martin in the instrument I formerly figured from his "Micrographia" (1742); in most of the other arrangements there was little

or no originality. The ball-joint as thus employed, when judged on its merits as a practical appliance, must be condemned, especially in connection with so large a microscope.

Andrew Ross seems never to have wearied of experimenting with different systems of fine-adjustment, and he must be credited with the successful evolution of the long-lever system acting on the nose-piece, which obtains in the highest class microscope of the present day—I refer to Powell and Lealand's. I have here microscopes by him embodying all the leading designs of fine-adjustments, constructed anterior to that system known as Zentmayer's (1876).

FIG. 20.



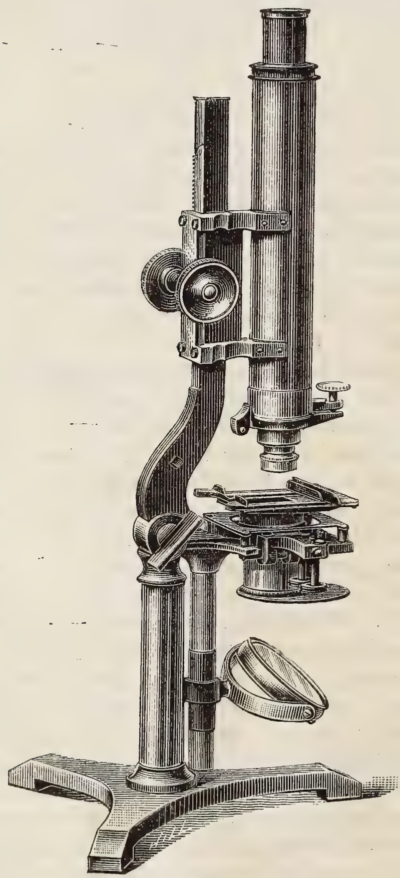
A. ROSS'S ACHROMATIC MICROSCOPE (EARLY FORM).

The earliest microscope I have seen by Ross is shown in Fig. 20; it has no inclining movement. The fine-adjustment consists of a long screw passing up the pillar and acting on a triangular sheath, within which the stem is applied to move with rack and pinion, the top of the stem being hollow, to receive either the cross-arm support for the single lens, or the limb of the compound body. The screw is actuated by a large graduated milled head beneath the tripod. The stage is supported by extra bracket-pieces on either side, intended primarily to avoid the flexure due to the pressure of the observer's hands in making dissections, and rectangular mechanical movements are applied, acting diagonally on either side of the stem by rather fine screws, so that the motions are very slow. The last point seems to me one in which the mechanism of the more modern microscopes has not met the requirements for high class work, for in the great majority of instruments the mechanical stage-movements act far too rapidly. This defect holds specially with the mechanism first devised, I believe, in France, but subsequently improved by Tolles, of Boston, and Wenham (the inventor of the binocular system known as the "Wenham"), in which the actuating milled-head pinions are placed vertically to the surface of the stage, by which the movements are confined within the circumference of the stage. By this modification a complete rotation of the object is effected with microscopes of the "Jackson" form; whereas, by the older system, in which the pinions project horizontally beyond the stage, the rotation is from one side of the limb to the other only, *i.e.*, is limited by the limb.

Ross seems to have modified the microscope above-figured by converting the pillar into a tail-piece, retaining the focussing-screw at the lower end; and at the upper end, near the pinion, he applied a cradle-joint to incline on a pillar and tripod. Then (apparently in rivalry with James Smith) he adopted a complicated system, consisting of a hinged stirrup-piece

encircling the sheath of the body-tube stem, lifting up this sheath by a fine screw at the back. He applied a similar mechanism to act on the nose-piece only, which is known as Jackson's system, as shown in Fig. 21, which figure is interesting also as proving that he worked out a form of "Jackson" limb supporting the body-tube. He tried various modifications of this fine-adjustment, and also

FIG. 21.



A. ROSS'S MICROSCOPE.

of the (probably anterior) system of a screw-cone acting on the nose-piece. I have met with one curious experimental device of his, in which he fitted a long screw at the back of the body-tube, the thread of which served as a rack to the pinion for the coarse-adjustment, whilst the turning of the screw itself, engaged in the teeth of the pinion, gave the slow motion, thus combining in one piece of mechanism both fine- and coarse-adjustments. He then appears to have followed the lead of Hugh Powell in applying the fine-adjustment to the stage, stimulated, doubtless, by the fact that the Society of Arts had awarded Powell a medal for a very elaborate form of this mechanism. From that period (about 1841) he seems to have definitely worked at the long-lever system applied to the nose-piece by means of what is known as the cross-arm supporting the body-tube on the stem, which he brought to great perfection, a perfection excelled only, so far as my experience informs me, by Powell and Lealand.

The encouragement given to the construction of microscopes by the Society of Arts, in awarding medals for special points of excellence, is a fact of so much interest that I here give a figure of Hugh Powell's microscope (Fig. 22, p. 1167), bearing the date 1841, and embodying the fine-adjustment applied to the stage.

As a piece of mechanism this fine-adjustment is extremely good, the motion is very delicate; but the application to the stage cannot be commended from our present point of view. The requirements of modern microscopy are not met adequately by the movement of the object between the objective and the condenser with every touch of the focal adjustment. With such an arrangement the difficulties of the manipulation generally are so great as to be practically intolerable. We have now become so accustomed to the use of exactly centered and focussed illumination, remaining constant upon the object, by means of substage mechanism, allowing modifications in the light to be rapidly made to suit the different objectives in use, that we could hardly test such a microscope as this in a manner to fairly estimate its mechanical excellence.

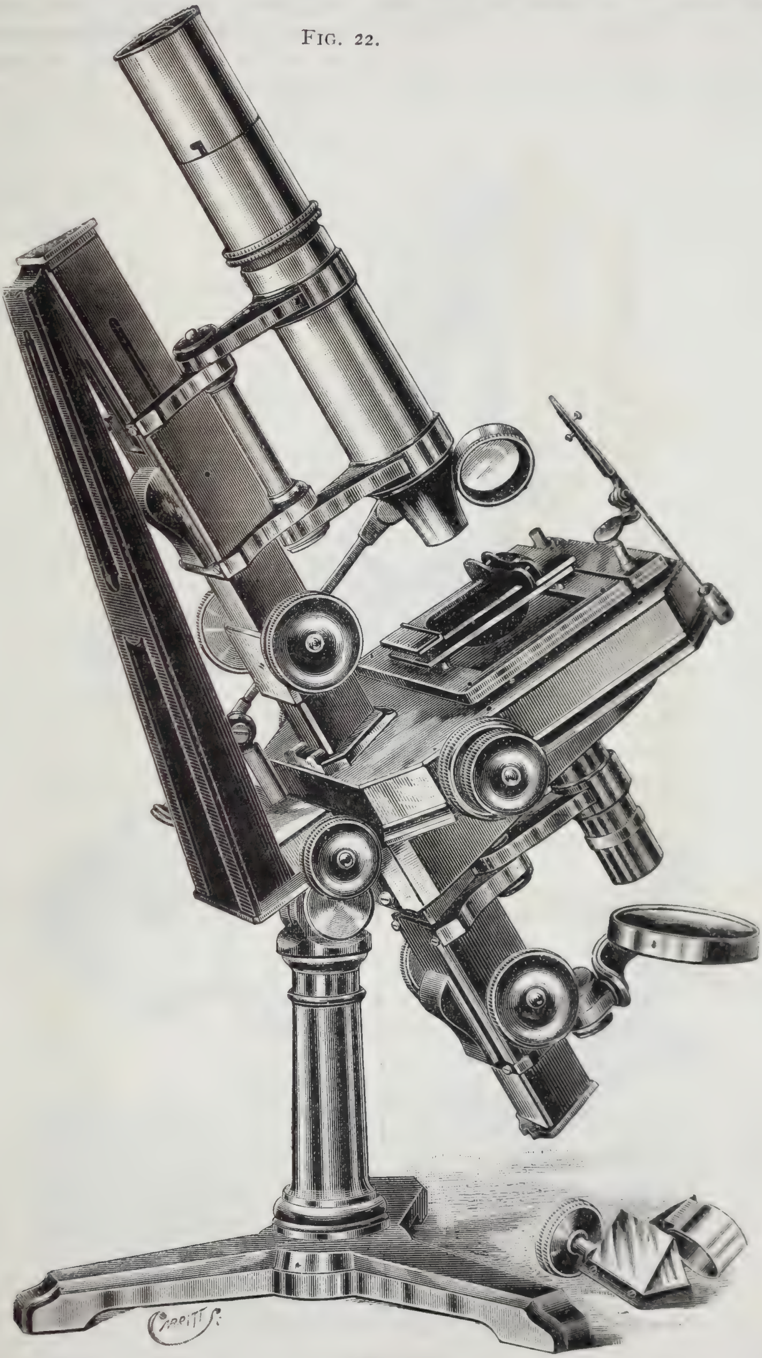
Another microscope of special interest is shown in Fig. 23 (p. 1168); it is the first model made by Smith and Beck embodying the "Jackson" limb and fine-adjustment. This system of fine-adjustment is now generally admitted to be defective; the position so near the nose-piece is not favourable for really critical work with our modern objectives of large aperture. The modification of it I formerly noted upon, devised by Dr. Hugo Schroeder, in which the actuating milled head is brought away from the nose-piece to near the eye-piece, and in which slowness of motion was obtained by the employment of a differential-screw, does not seem to have stood the test of experience, for

I observe that the makers (Ross & Co.) have given up the differential-screw in favour of a direct-action screw of fine pitch ; and according to the experience of microscopists who have used the later system it still leaves much to be desired.

Of other systems of fine-adjustment that have come under my notice I may briefly note:—

1. The Zentmayer plan of making the fine-adjustment slide carry the coarse-adjustment with all its weight of body-tube, eye-piece,

FIG. 22.



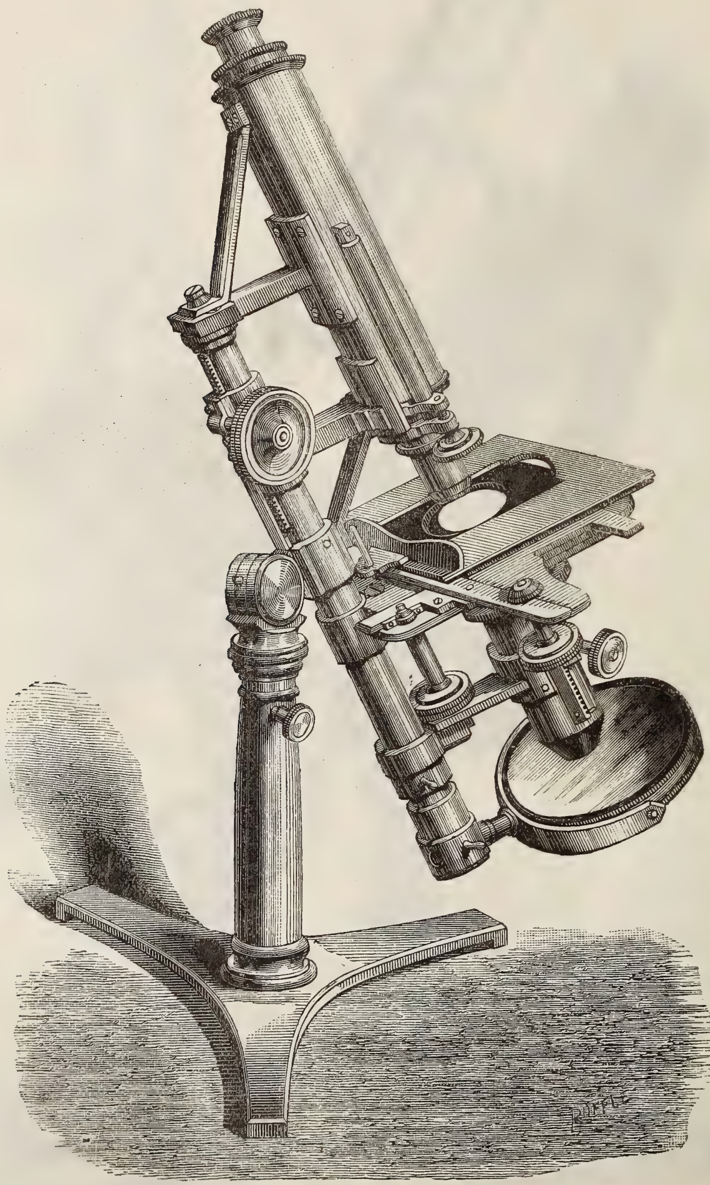
H. POWELL'S MICROSCOPE (1841).

objective, milled heads, &c., has long seemed to me defective, whether actuated by a lever and screw, or by a screw-cone.

2. Swift's long-lever actuating the body-tube, which I formerly commended, is well-spoken of by those who have worked with it continuously, and is probably the best fine-adjustment yet applied to the "Jackson" microscope.

3. Seibert and Krafft's parallel-bar suspension of the body-tube, and the analogous system, devised by Bausch and Lomb, in which broad parallel spring-plates carry the body-tube, have been largely employed for "economical" microscopes; perhaps, indeed, no better systems have ever been employed for such microscopes. I note, too, that in the latter form Messrs. Swift have applied a lever, by which the focussing is rendered more sensitive.

FIG. 23.



SMITH AND BECK'S MICROSCOPE.
(JACKSON'S FIRST FORM.)

4. The differential-screw, as proposed by Rev. James Campbell, has met with much approval from Mr. E. M. Nelson, and is regarded by him as decidedly superior to the usual "Continental" fine-adjustment, as employed by Hartnack, Nachet, Zeiss, Leitz, or Reichert. Personally I have not found the differential-screw mechanism sufficiently well made to impress me favourably.

5. Various systems of fine-adjustment by tilting the stage, which are mostly revivals of what were generally regarded as obsolete forms, have been brought forward with more or less pretension recently, and I should hope I need not criticise them.

Regarding the utility or otherwise of a racking and centering substage, I shall only say that, in my opinion, every microscope with which it is intended to do serious work should have such a substage; and if the opticians would supply an adapter fitted with a pivoting diaphragm-carrier, or even a disc of apertures, so that objectives could be conveniently used as condensers, they would add much to the interest of popular microscopy. As it is, I fear the great majority of possessors of microscopes are not aware of the immense advantages attendant upon the use of condensers, achromatic condensers being, of course, far preferable, for it is with them alone that it is really practicable to observe objects projected, as it were, in the image of the source of light focussed by the condenser.

It is, without doubt, highly desirable to have a series of achromatic condensers, of different foci, to suit the field of view of objectives of different power. It appears not to be generally known that distancing the lamp from the microscope will give a considerable range of size of luminous field, with one and the same condenser.

As to the general form of microscope that I most approve for high-class work, I have never seen any instrument to compare favourably with that of Powell and Lealand. I do not hold with certain microscopists—notably Mr. E. M. Nelson—in considering the tripod base, as made by Powell and Lealand, the only really good form. I think the projection of the feet beyond the vertical plane of the tail-piece, thus restricting the free use of the mirror-arms, when the instrument is vertical, or only slightly inclined, is inconvenient. But this is only a minor point, which I mention because I think too much stress has been put upon the merits of this or that particular form of construction of the base, regardless of the fact that the *essential* matters are the absolute steadiness of the instrument combined with the utmost freedom for the manipulations—which matters, so far as they are dependent on the form of the base, admit of many varieties of design.

One ambitious form of microscope has been recently brought prominently forward, which is shown in Fig. 24 (p. 1170). We have here an elaboration of mechanical movements and illuminating arrangements, the complexity of which almost defies comprehension. I had intended to deal with it critically, but have been forced to give it up in despair of rendering myself intelligible. Can anyone other than the inventor approve of such a design as a practical microscope for high-class work?

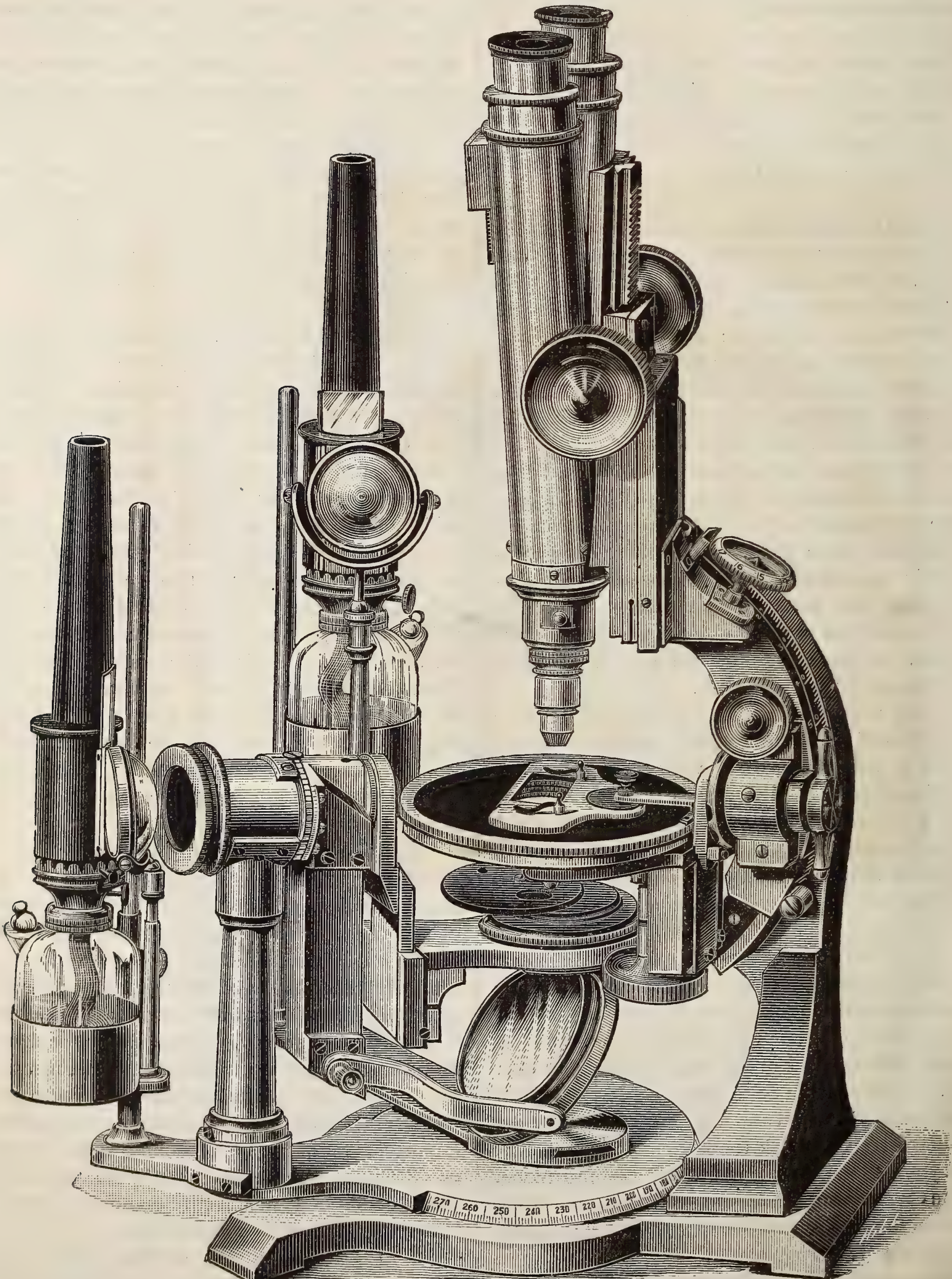
Regarding the best form of student's microscope, the choice seems, upon a cursory examination, to be almost unlimited. But if the student is to be advised to train his hand and eye in the critical estimation of optical images produced by the microscope — to become, in short, an expert in the use of the microscope—then the range of choice is cut down to very moderate limits. He *must* have an instrument provided (1) with a centering sub-stage, without which critical microscopy is impossible, for an achromatic condenser is an *absolute necessity*, and such a condenser *cannot* be properly used without centering arrangements; (2) he must have a fairly good fine-adjustment, otherwise the waste of time in manipulating will be enormous, if, indeed, he ever succeeds in getting the *best* work out of his optical appliances.

I do not attempt to guide the selection of a student's microscope by mentioning that of any particular optician. Efficient instruments of this class can be supplied readily by most of our opticians, probably more satisfactorily than they can be obtained from any foreign opticians. This seems to me merely a question of demand and supply. If the student insists, however, upon having the lowest priced instrument regardless of mechanical efficiency, he will doubtless obtain what he seeks among the importers of low-class microscopes from France or Germany—microscopes made to suit the price demanded without reference to their efficiency as working instruments.

As to the objectives, oculars, and condensers that should be in the hands of a student, they should be the best his means

will allow him to obtain. The advantage, from every point of view, due to Professor Abbe's recent introduction of apochromatic objectives and compensating eye-pieces can hardly be overrated; on this point the proofs are beyond all possibility of doubt. I do not venture to affirm that we have thus reached the highest attainable point of excellence with our optical appliances; but the practical evidence of advance furnished by a careful comparison between the new "apochromatic" system of Abbe and the ordinary "achro-

FIG. 24.



A MODERN MICROSCOPE.

matic " system, leaves no room for uncertainty as to the absolute superiority of the new system.

The apochromatic objectives are the direct outcome of the new kinds of optical glass due to the theoretical and experimental researches of Professsor Abbe and Dr. Schott, which have been promoted to a considerable extent by the German Government. The compensating eye-pieces are the development of certain theoretical views long entertained by Professor Abbe, as to the possibility of correcting, by specially-constructed eye-pieces, defects in the image projected by the objective which cannot be corrected in the construction of the objective. They are, therefore, useful in improving the definition of many achromatic objectives of ordinary construction, and the student must hence be advised to obtain them.

At the close of my previous Cantor Lectures, I expressed my strong conviction that the new glass would lead to immediate improvement in the optical power of the microscope—would, in fact, give microscopy a new start. The results

Fig. 25.

Proboscis of Blow-fly × 70 diameters.

Fig. 26.

Amphipleura pellucida × 1860 diameters.

obtained by Zeiss, under the direction of Professor Abbe, are such as must raise our expectations of still further progress. On this matter I speak with special information, since I have had the privilege of minutely inspecting the optical and mechanical workshops of Zeiss, in Jena, under the guidance of Professor Abbe and Dr. Roderick Zeiss, and can therefore testify to the thoroughness of the arrangements to insure general accuracy of workmanship — a thoroughness that must necessarily lead to still greater technical perfection of work, a point in which Professor Abbe frankly admitted certain English and American opticians had hitherto held the lead.

It is gratifying, also, to know that our opticians have not been dilatory in recognising the utility of the new optical glass, and in thus pressing forward the improvements initiated by Professor Abbe; for it would hardly correspond with the traditions our opticians have inherited were they to neglect the practical improvement of the microscope, from whatever quarter the initiation might come. In this matter there can be no kind of jealousy to mar the loyal acknowledgment by all microscopists

and opticians of the great services rendered to microscopical science by Professor Abbe.

In conclusion, it has seemed to me that graphic évidence of what the new apochromatic objectives will do in the hands of a skilled manipulator with the microscope is the best evidence I can give of their excellence. I therefore reproduce in photozincography two photographs recently made by Mr. E. M. Nelson, giving his data of their production.

Fig. 25 (p. 1171), *Proboscis of Blow-fly*, × 70 diameters with Zeiss's 24mm. (= one inch) apochromatic objective, ·3 N.A. Illumination, solid cone of light from Nelson's low-power condenser of 30° aperture, image of lime (oxyhydrogen) being focussed on the object. Full aperture of objective and condenser, using Zeiss's × 3 projection eye-piece. Slow isochromatic plate, exposure five seconds. Powell and Lealand's No. 1 Microscope.

Fig. 26 (p. 1171), *Amphipleura pellucida*, × 1,860 diameters with Zeiss's 3mm. (= ⅛-inch) apochromatic objective, 1·428 N.A. Illumination, Powell and Lealand's oil-immersion condenser, 1·4 N.A., and slot; oxyhydrogen light, using Zeiss's × 3 projection eye-piece. Camera 5 ft. 6 in. long. Slow isochromatic plate, exposure one hour. Powell and Lealand's No. 1 Microscope.

Miscellaneous.

SUBSOIL MAPS.

The interest which the Society of Arts has taken in geology has always been on the side of its direct bearings on agriculture. Long before the study of stratigraphical geology had commenced, it had offered a premium for a "map of the soils" of England. [See *ante*, p. 393]. At the recent International Geological Congress there were distributed copies of an extract (196 pp. woodcuts and two plates) of the Bulletin de la Société Belge de geologie, de paléontologie et d'hydrologie, giving an account of a new portable boring apparatus and the manner of working it, with an illustration from one of the sheets of the Belgian Geological Survey showing the application of its use. [May 29, 1888, by MM. E. van den Broeck and A. Rutot, Conservators at the Royal Museum of Natural History of Belgium.] From this it appears it has been in use by some members of the Belgian Geologicnl Survey for over seven years, though it is little known in this country. Messrs. Clement Reid and A. Strahan, of her Majesty's Geological Survey, have, however, employed it in the re-survey of the Isle of Wight, the map of which has just been completed, and they have found the rapidity and ease with which it can be used of great service. With it they have been enabled to settle the uncertain points of the geology of the north part of the island, resulting in an entire re-mapping. It has also been employed in the re-survey of Norfolk. Its use for subsoil mapping is very apparent. The old boring apparatus was a cumbersome affair, requiring time for its erection and many men to work it. For deep borings, hard rocks, and for cases where a "core" is needed, it will, in some form, continue to be employed. But the new borer is not intended for deep borings; it is designed for the more rapid and more exact examination of the distribution of soils to the depth of a few yards. It requires but two men, and being easily portable, many borings near to one another can be taken in a short space of time, and the varying limits of different subsoils can be thus ascertained with an accuracy that has not before been attained. The actual borer is fashioned like the end of a worm-augur not quite three inches in diameter, and having ten turns in it. The upper end is arranged to be joined on to a "connecting rod," to which a cross handle for rotation is attached. When it is withdrawn it is found that although no "core" is brought up, the "worms of the screw" of the augur bring up, closely compacted, a sample of the soil it has reached. By means of a series of connecting rods a depth of many yards can be readily bored.

General Notes.

Consular Reports.—A correspondent writes, *à propos* of the letters now appearing in some of the newspapers on foreign international exhibitions, drawing attention once more to the neglect with which manufacturers and traders treat the information with which they are supplied by British Consuls. He gives, as an instance, the fact that, not long ago, the United States Consul at an important Spanish town wrote a report on stoves, the result of which was that he had over thirty applications for further information from various firms in the States, and that a good many applications were made to the British Consul of the town. This gentleman supplied a great deal of information to a firm in England, who were informed that if they sent some stoves out at once they would be in time to anticipate the supply from America. The firm in question, however, did not care to take the trouble, and the result has been that a large business which the natives were ready and probably would have preferred to carry on with England, has gone into American hands. In many cases consuls are blamed for not assisting English trade; but this appears to be an instance in which the assistance offered by the consul was disregarded by the parties interested in this country.

Journal of the Society of Arts.

No. 1,878. Vol. XXXVI.

FRIDAY, NOVEMBER 16, 1888.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PHONOGRAPH AND GRAPHOPHONE.

The applications for tickets for the meetings of the Society when Colonel Gouraud's paper on the "Phonograph" (November 28th), and Mr. Edmunds's paper on the "Graphophone" (December 5th), will be read, have been so numerous that the supply of tickets for the "Phonograph" meeting has been exhausted, and no more can safely be issued. A few tickets still remain for December 5th.

Members are reminded that no person, whether a member or not, can be admitted without a ticket.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-fifth Session of the Society will be held on Wednesday, the 21st November, when the Opening Address will be delivered by The Duke of Abercorn, C.B., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

November 28.—"The Phonograph." By Col. Gouraud. Sir Frederick Bramwell, D.C.L., F.R.S., Deputy-Chairman of the Council, will preside.

December 5.—"The Graphophone." By Henry Edmunds. W. H. Preece, F.R.S., will preside.

December 12.—"Explosives." By W. H. Deering, F.C.S. Sir Frederick Abel, C.B., D.C.L., F.R.S., President of the Government Commission on Explosions, will preside.

December 19.—"Standards of Light." By W. J. Dibdin, F.I.C., F.C.S.

Papers for which no dates have as yet been fixed :—

"Manufacture of Sèvres Porcelain." By Edouard Garnier (late of the Sèvres Manufactory).

"The Forth Bridge." By Benjamin Baker, M.Inst.C.E.

"The Channel Tunnel." By Colonel Hozier.

"Salt." By Peter Lund Simmonds.

"The Construction of Photographic Lenses." By Conrad Beck.

"The Manufacture of Aluminium." By William Anderson, M.Inst.C.E.

"Automatic Selling Machines." By J. G. Lorrain.

"Secondary Batteries." By W. H. Preece, F.R.S.

"Arc Lamps and their Mechanism." By Prof. Silvanus P. Thompson.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock :—

January 29; February 19; March 12; April 2, 30; May 21.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock :—

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The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock :—

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The following courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock :—

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WALTER CRANE, "The Decoration and Illustration of Books." Three Lectures.
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May 6, 13, 20, 27.

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Two Juvenile Lectures, entitled "How Chemists Work—an example to Boys and Girls," by HENRY E. ARMSTRONG, Ph.D., F.R.S., will be given on Wednesday evenings, January 2 and 9, 1889, at Seven o'clock.

Miscellaneous.

BATH STONE.

The industry of Bath, *par excellence*, is the quarrying of the famous warm-toned freestone, which possesses the remarkable qualities of durability and easy working at the same time. There are edifices still extant, built of Bath stone, that were erected in the early portion of the Christian era, and which evince a remarkable state of preservation. These include the recently discovered Roman baths at Bath; the Saxon church of Bradford-on-Avon, begun in 705 A.D.; and Lacock Abbey, founded in 1230, all visited by members of the British Association during their late meeting in the city. The excursion to Lacock Abbey also included a visit to the Box and Corsham Down quarries, from the former of which documentary evidence shows the stone to have been obtained with which the Abbey was erected. The beds of Bath stone are contained in the formation known as the Great or Bath Oolite.

Although, in accordance with geological investigation and deductions, Bath stone should extend over a considerable area, this is found, in practice, not to be the case, the area being a tract about 30 miles long and 10 miles wide, extending to the east of Bath between Chippenham on the north and Trowbridge on the south. But even in this limited area the stone has only been found at a workable depth in certain localities, though innumerable bore holes and trial shafts have been put down to prove the ground. Moreover, the beds, though found almost horizontal where worked, vary greatly, within short distances, from one unbroken stratum averaging 7 feet thick, to several strata measuring, together, 21 feet. The quality also differs in the several localities, which yield stone adapted to various usages.

The stone was only quarried for local use until, in 1841, the driving of the famous Box tunnel of the Great Western Railway revealed the existence of the Box and Corsham beds, which are the most valuable and extensive. The method of extracting the stone at these quarries, as they are called, though really mine workings, is as follows, being that generally adopted throughout the district, with the necessary modifications due to the stratification. An adit or heading is driven from the surface of the hill side; and stalls are cut right and left, though not opposite to one another, the size of the pillars left depending on the solidity of the rock. Where the stone has been deposited regularly, the pillars and stalls are regular; but more frequently, owing to flaws and faults, a plan of the workings presents anything but a regular appearance. The blocks are taken out as large as possible consistent with practicable working. First a groove is holed in the face with three successive picks (of diminishing size but with handles increasing in length), about nine inches in front and six inches at back, to a horizontal depth of five feet. A vertical saw-cut is made at right angles to the groove, and from it, downwards, to the first natural parting, and then another about five feet from it in front and four feet at the back, when wedges are driven in at the parting until the block breaks off, frequently at the whole horizontal depth of five feet, when it is hauled out by a crane, assisted by crowbars. After the first block is extracted the work is easier, as room is afforded for a man to get in and make a saw-cut at the back as well as at the remaining sides.

All attempts at superseding this primitive method of working have proved unavailing, as the object is to get out blocks of as large size as possible; and no machinery has yet been found sufficiently adaptable to the irregularities of the beds. The blocks are run out of the quarry and down to the loading wharf on trucks running on a small-gauge tramway, generally down hill all the way. The stone from the Corsham quarry is stacked to "season" for a whole summer before being sent away. A crane for stacking the blocks in the workings, with telescopic pillar adaptable to the varied heights of the workings, has been designed by Mr. S. Griffin, of Bath. Each block, besides being carefully selected in the quarry, is subject to a double inspection on the surface, the absence of metallic ring on its being struck by a hammer, indicating an internal flaw. An average sample is of 2·2 specific gravity when dry, 100 pounds of stone absorbing only 9 pounds of water; and in actual practice it will stand a pressure of 70 tons per square foot without cracking. Analysis shows:—Carbonate

of lime 97·2, oxide of iron and alumina, 1·6, silica 1, and carbonate of magnesia, 0·2.

Since the beginning of the present year, all the Bath stone interests, except the owners of two quarries, have been united under the style of "The Bath Stone Firms, Limited," with the object of facilitating the selection by architects of the stone best suited to their requirements, and of diminishing general expenses, though not of increasing the price of the stone, all varieties of which are sold at 11d. per cubic foot, with no prospect of an advance.

TEA CULTURE IN NATAL.

A peculiar and fatal blight attacked the coffee trees in Natal a few years ago, which induced some of the coffee planters to abandon that pursuit and to undertake the cultivation of the tea plant instead. This experiment, says the United States Consul at Cape Town, began in 1877, during which year a few acres were planted with Ceylon and other varieties of Indian tea-seed. The result proved so encouraging that the area of tea cultivation was rapidly enlarged. The ground under tea culture of one of the chief tea-growing estates in Natal, lately visited by Consul Siler, is situated 1,000 feet above sea level, possessing a deep soil, with a fair proportion of sand and decomposed granite, vegetable, and other organic matter. The land selected is generally open and level, and is well ploughed. The rows are laid out about 5 ft. apart, and the plants are placed therein about 4 ft. 6 in. apart. If the planting is successful, a small crop is obtained after the first year, which increases in quantity from year to year until the maturity of the plant, which is attained the sixth year, and after which it will continue to yield for an indefinite period, according to the care bestowed upon it. During the whole period of growth the greatest care is exercised to keep the ground loose and clear of grass and weeds. Picking commences in September—that is after the dry season has passed—and is continued every ten days or three weeks till June, according to the season. A good season will yield from 20 to 22 pickings, or "flushes," and a poor one only 17 or 18. The picking is performed almost entirely by Hindoo Indians, or coolies, of which the colony of Natal contains about 30,000. It is declared by tea planters in Natal that, without the Hindoo labour, it could never be hoped to make this new industry a success. The reason assigned for this is that the Kaffir is so erratic and unstable in his disposition, and so frequently engrossed in the affairs of his own domestic relations, that he can never be relied upon to keep his engagements for the morrow; whereas the Hindoo immigrant is patient and industrious, rarely showing an inclination to wander beyond the field of his labour; is tractable, docile, and never discontented, and may always be depended upon during the busiest as well as the slackest season. A Hindoo will pick from thirty to forty pounds of green tea leaves per day, while a native will gather not more than half that quantity. The several processes through which the green tea passes in its preparation for market and use consist of withering, rolling, fermenting, drying, sorting, and packing. The object of withering is to allow the leaf to roll or curl easily, and to prevent its breaking up during the rolling and drying process. The leaf is first laid upon the withering-floor, and then spread out in thin layers, and constantly stirred about by Indian boys and girls. This operation is most expeditiously and satisfactorily performed when the temperature is hot and dry. Rolling is the next stage, the object of which is to break up the juice cells of the withered leaf, and thus allow of fermentation taking place. The operation is performed by a machine which moves with a double eccentric action, and works like two human hands rolling together. This is a great labour-saving apparatus, performing the work of eighty pairs of hands in one day. After having been sufficiently rolled, the leaves, in a sticky condition, fall from the machine into large trays, and are carried to the fermenting tables. The fermenting operation is the most important and critical of all the manipulations, the quality of the tea greatly depending upon the fermentation being arrested at the proper time, and it is necessary to have drying machinery capable of receiving rapidly all the tea as fast as it is sufficiently fermented. If over fermented, the tea is depreciated in colour and quality. From the fermenting tables the tea is passed through the dryer, which consists of a long cylinder or tube, two feet in diameter, with a flue in the centre which can be raised or depressed. This cylinder revolves at a rapid rate, keeping the tea in constant motion, thus preventing it from burning, which would otherwise occur, as the heat is very intense. The tea is driven through the heated air of the cylinder by a fan, and the leaf as it dries becomes rounded, and gravitating to the lower end of the machine is collected in trays, and now for the first time presents the appearance of tea as it is accustomed to be seen. Sorting consists of passing the dried leaves through a series of graduated sieves, which being kept in motion by an eccentric action, sifts and divides the tea into the various grades. The top sieve having the largest meshes, that which remains in it after the vibratory sifting is the coarsest, and is called "Souchong," and is the lowest grade. What remains in the second sieve is called "Pekoe Souchong," in the third "Pekoe" and in the fourth "Flowery Peko." The packing process is very simple, though important. The tea is first weighed in single pounds, covered with tea lead, and labelled according to quality. It is then placed in boxes lined with tea lead, of from five to fifty pounds weight, to suit the requirements of the trade. The expenses of these packing boxes, which would otherwise be considerable, is reduced to a minimum in consequence of a suitable wood for the purpose growing in large quantities immediately

contiguous to the tea estates. No attempt has been made to introduce Natal teas into foreign markets, as the demand at home has, up to the present, been fully equal to the entire production. In conclusion, Consul Siler states that he has been assured by one of the largest tea planters in the colony that he can dispose of his entire crop in the Durban market at prices 25 per cent. cheaper, quality for quality, than the foreign article can be laid down there, and at the same time realise a large profit on his labour and outlay. The Consul adds that indications now point to Natal as one of the great tea-producing countries of the future.

Notes on Books.

PENOLOGICAL AND PREVENTIVE PRINCIPLES, with special reference to Europe and America. By William Tallack, Secretary to the Howard Association. London: Wertheimer, Lea and Co. 1889. 8vo.

The author deals with a number of questions connected with the large subject of the punishment and prevention of crime. The first chapter is devoted to the principles essential in diminishing crime and pauperism, and among those essentials the author discerns the importance of the following:—1. That the proposed means of restricting social maladies do not become encouragement of the very evils to be repressed. 2. The necessity of avoiding the divorce of elements which should be always held in union. 3. An ever-vigilant hesitation as to the fashionable dogmas or popular conclusions is requisite. In subsequent chapters, the author treats of prison systems and officers, separation and classification, life imprisonment, corporal punishment, the police, and neglected youth and juvenile delinquency.

THE BOOK OF THE LANTERN. By T. C. Hepworth, F.C.S. London: Wyman and Sons. 1888.

The optical lantern—this is the title which seems to be generally superseding the old name of "magic lantern"—is now so extensively used for educational purposes, that there is abundant room for a work such as that of Mr. Hepworth. The writer's object is to provide a complete manual for the use of those who are in the habit of constantly employing the lantern for purposes of instruction and amusement. He describes the construction of the oxyhydrogen lantern—he says but little about the various forms of oil lamps, now largely used, and nothing, or next to nothing, about the electric lamp, though where electricity is readily available it possesses many obvious advantages in the way of convenience and power. He gives full and careful instructions for the manipulation of the lantern, and does not omit to describe the numerous subsidiary appliances required for proper working. The various photographic methods of preparing lantern slides are given in some detail, and full instructions for colouring slides are also provided. A chapter deals with the apparatus for experimental demonstration in the lantern, a part of the subject which might easily have been treated at greater length, and which indeed, perhaps, Mr. Hepworth may be inclined to enlarge in a future edition.

THE LONDON COUNTY COUNCIL: its duties and powers, according to the Local Government Act of 1888, incorporating the duties transferred from the Metropolitan Board of Works and other bodies. By George Laurence Gomme, F.S.A. London: David Nutt. 1888.

This little volume contains a full account, arranged in alphabetical order, of all the duties and powers to be exercised by the new London County Council. Not only are all the clauses of the Local Government Act of 1888 given, but also references to the Acts of Parliament connected with the Metropolitan Board of Works, whose duties are transferred to the London County Council, are included. In one alphabet will be fonnd information respecting the buildings, monuments, parks, open spaces, &c., placed under the control of the County Council, as Albert-bridge, Battersea-park, Brook-green, Clapham-common, Cleopatra's Needle, &c., references to sanitary matters, &c. Information is also included on the elections, costs, duties of the council, the constituencies, &c. The author writes:—"The treatises which have been hitherto issued, explanatory of the new Act, deal only with its legal aspect; but there seemed still to be needed a summary of the powers and duties of the London Council, so unique in many of its attributes. The present volume is designed to meet the need. It is arranged alphabetically, with simple cross references. To describe the various duties and powers in all cases the exact words of the Act are used, or where the particular duty or power is transferred from other bodies, a summary is given compiled from officially published reports." An introduction is prefixed in which the author refers to the history of the Government of London, and points out some of the lines on which the work of the London County Council is likely to grow.

THE LIBRARY.

The following books have been added to the Library since the last announcement:—

Bottone, S. R.—Electrical Instrument Making for Amateurs. (London: Whittaker and Co., 1888.) Presented by the Publishers.

Bridge, John.—From Tilbury to Torbay, 1885–7. (London: Gilbert and Rivington, 1888.) Presented by the Author.

Brooks, C. P.—Cotton Manufacturing. (Blackburn: C. P. Brooks.) Presented by the Author.

Burns, William.—A Manual of the Manufacture of Gas. (London: E. and F. N. Spon, 1887.) Presented by the Author.

Coghlan, T. A.—The Wealth and Progress of New South Wales, 1886-7. (Sydney: George Robertson and Co., 1887.)

Cross, C. F., E. J. Bevan, and C. M. King, in association with E. Joynson.—Report on Indian Fibres and Fibrous Substances, exhibited at the Colonial and Indian Exhibition, 1886: with Notes of Methods of Treatment and Uses prevalent in India, by Dr. George Watt, C.I.E. (London: E. and F. N. Spon, 1887.) Presented by the Authors.

Favenc, Ernest.—The History of Australian Exploration from 1788 to 1888. (Sydney: Turner and Henderson, 1888.)

Galloway, Robert.—The Fundamental Principles of Chemistry. (London: Longmans, Green and Co., 1888.) Presented by the Publishers.

Greenwood, Thomas.—Museums and Art Galleries. (London: Simpkin, Marshall and Co., 1888.) Presented by the author.

Harris, William A.—A Technical Dictionary of Fire Insurance. (Liverpool, 1886.) Presented by the Author.

Kalakoutsky, Gen. Nicholas.—Investigations into the Internal Stresses in Cast Iron and Steel. (London, 1888.) Presented by William Anderson, M. Inst.C.E.

Kentish, Thomas.—The Gauger's Guide and Measurer's Manual (London: Dring and Fage, 1861); Timber Measuring (London: Dring and Fage, 1866); A Treatise on a Box of Instruments and the Slide-rule (London: Dring and Fage, 1847). Presented by Edward Jones.

Kerby, Henry, and Peregrine Varnals.—Practical Guide for Trade Mark Owners. (London, 1887.) Presented by the Trade Mark Protection Association.

Kolbe, Dr. Hermann.—A short Text-book of Inorganic Chemistry, translated and edited by T. S. Humpidge, Ph.D. (London: Longmans, Green and Co., 1888.) Presented by the Publishers.

Lloyd, Samuel.—A National Canal between the Four Rivers a National Necessity, by Samuel Lloyd. (London: James Hogg and Sons.) Presented by the Author.

Mann, Mrs.—A Sketch of the Life and Work of Robert James Mann, M.D., F.R.C.S. (1888.) Presented by the Author.

Meath, Earl of. — Prosperity or Pauperism. (London: Longmans, Green and Co., 1888.) Presented by the Publishers.

Parker-Rhodes, C.E.—Our Daily Water Supply. (London: E. W. Allen, 1887.) Presented by the Author.

Peek, Francis. — Social Wreckage. (London; William Isbister, Limited, 1888.) Presented by the Howard Association.

Planté, Gaston. — The Storage of Electrical Energy, translated by P. B. Elwell. (London: Whittaker and Co., 1887.) Presented by the Publishers.

Pole, William, F.R.S.—The Life of Sir William Siemens, F.R.S., D.C.L., LL.D. (London: John Murray, 1888.) Presented by the Executors of the late Sir William Siemens.

Salomons, Sir David, Bart., M.A.—Management of Accumulators and Private Electric Light Installations. (London: Whittaker and Co., 1888.) Presented by the Publishers.

Stopes, C. — The Bacon - Shakspere Question. (London: T. G. Johnson, 1888.) Presented by the Publisher.

Unwin, William C.—The Testing of Materials of Construction. (London: Longmans, Green and Co., 1888.) Presented by the Publishers.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 19...British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, Nov. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by W. Worby Beaumont, "Friction-brake Dynamometers."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.

Pathological, 53, Berners-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. J. W. Hulke, "Contributions to the Skeletal Anatomy of the Mesosuchia." 2. Mr. Oldfield Thomas, "The Small Mammals of Duval County, South Texas." 3. Mr. Oldfield Thomas, "The Mammals obtained by Mr. C. M. Woodford during his second expedition to the Solomon Islands." 4. Mr. L. Taczanowski, "Liste supplémentaire des Oiseaux recueillis en Corea par M. Jean Kalinowski."

WEDNESDAY, Nov. 21...SOCIETY OF ARTS, John-street, Adelphi, 8 p.m. Opening Address of the 135th Session, by the Duke of Abercorn, Chairman of the Council.

Metereological, 26, Great George-street, S.W., 7 p.m. 1. Mr. G. J. Symons, "Results of an Investigation of the Phenomena of English Thunderstorms during the years 1857-59." 2. Mr. Robert H. Scott, "Notes on the Meeting of the International Meteorological Committee at Zurich in 1888." 3. Exhibition of Models of Hailstones.

Geological, Burlington-house, W., 8 p.m. 1. Mr. R. Lydekker, "Notes on the Remains and Affinities of Five Genera of Mesozoic Reptiles." 2. Mr. W. H. Shrubsole, "Notes on the Radiolaria of the London Clay." 3. Mr. E. T. Newton, "Description of a New Species of *Clupea (C. vectensis)*."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Paper on "Minton's Pottery and Ceramic Wares," illustrated by examples from the Stoke-upon-Trent Works.

THURSDAY, Nov. 22.—Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Henry Edmunds, "A System of Electrical Distribution."

FRIDAY, Nov. 23.—Clinical, 53, Berners-street, W., 7½ p.m.

SATURDAY, Nov. 24.—Physical Science School, South Kensington, S.W., 3 p.m. 1. Capt. Abney, "The Measurement of the Luminosity of Coloured Surfaces." 2. Professor Rücker, "The Suppressed Dimensions of Physical Quantities."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year.

TRANSACTIONS, &c.

American Academy of Arts and Sciences, Proceedings and Memoirs.
American Chemical Society, Journal.
American Philosophical Society, Proceedings.
American Society of Civil Engineers, Transactions.
Association of Engineering Societies, Journal.
Bath and West of England Society, Journal.
Berlin, Polytechnische Gesellschaft, Verhandlungen
Birmingham Philosophical Society, Proceedings.
British Association for the Advancement of Science, Report.
British Horological Institute, Horological Journal.
Camera Club, Proceedings.
Canada, Royal Society of, Proceedings and Transactions.
Canadian Institute, Proceedings.
Central Chamber of Agriculture, Proceedings.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
Doubs, Société d'Emulation du, Memoires.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Gas Institute, Transactions.
Geological Society, Quarterly Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institute of Patent Agents, Transactions.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Kew Gardens Bulletin.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Liverpool Polytechnic Society, Journal.
London Chamber of Commerce, Chamber of Commerce Journal.
Lyons, Société des Sciences Industrielles, Annales.
Manchester Literary and Philosophical Society, Memoirs.
Manitoba Historical and Scientific Society, Transactions.
Mauritius, Société Royale des Arts et des Sciences, Transactions.
Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Indian Association, "The Indian Magazine."
Nova Scotian Institute of Natural Science, Proceedings and Transactions.
Pharmaceutical Society, Journal and Transactions.
Philadelphia, Academy of Natural Sciences, Proceedings.
Philadelphia, Engineers Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Rome, Giornale del Genio Civile.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, Proceedings and Journal.
Royal Geological Society of Ireland, Journal.
Royal Institute of British Architects, Journal of Proceedings and Transactions.
Royal Institution, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Internationale des Electriciens, Bulletin.
Société Nationale d'Acclimatation de France, Bulletin Mensuel.
Society of Antiquaries, Archæologia and Proceedings.

Society of Biblical Archæology, Transactions and Proceedings.
Society of Chemical Industry, Journal.
Society of Cymmrodorion, Magazine.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Telegraph Engineers and of Electricians Journal.
South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.
Vienna, Das Handels-Museum.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.
Commissioners' of Patents Journal.

Weekly.

Admiralty and Horse Guards Gazette.
Amateur Photographer.
American Architect and Building News.
American Manufacturer and Iron World.
Architect.
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
British and Colonial Druggist.
Builder.
Builders' Weekly Reporter.
Building (New York).
Building News.
Chemical News.
Chemist and Druggist.
Colliery Guardian.
Colonies and India.
Cosmos; Revue des Sciences.
Country Brewers' Gazette.
Electrical Engineer.
Electrician.
Electricité.
Engineer.
Engineering.
Engineering and Building Record (New York).
English Mechanic.
European Mail.
Farmer and the Chamber of Agriculture Journal.
Gardeners' Chronicle.
Gardening World.
Gas and Water Review.
Gas World.
Herapath's Railway Journal.
Indian Engineer.
Industries.
Invention.
Iron.
Iron and Coal Trades Review.
Iron and Steel Trades Journal.
Ironmonger.
Jewelers' Weekly (New York).
Journal of Gas Lighting.
Journal d'Hygiène.
Journal des Mines.
Land and Water.
London Iron Trade Exchange.
Medical Press and Circular.
Metropolitan.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Musical World.
Nature.
Office.
Photographic News.
Photographic Times and American Photographer.
Pottery and Glassware Reporter (Pittsburgh).
Practical Engineer.
Produce Markets' Review.
Queen.
Revue Industrielle.
Sanitary Engineering.
Sanitary News (Chicago).
School Board Chronicle.
Schoolmaster.
Science (New York).
Scientific American.
Scientific News.
Statist.
Telegraphic Journal and Electrical Review.
United States Patent Office, Official Gazette.
Warehousemen and Drapers' Trade Journal.

Fortnightly.

American Gas Light Journal.
Anthony's Photographic Bulletin.
Brewers' Guardian.
Corps Gras Industriels.
Finance Chronicle.
Gaceta Industrial.
Ingeniero y Ferretero Espanol y Sud-Americano.
Irish Builder.
Jeweller and Metalworker.
Monde de la Science et de l'Industrie.
Moniteur des Produits Chimiques.
Planters' Gazette.
Publishers' Circular.
Revue Internationale de l'Electricité.

Monthly.

Analyst.
Antiquary.
Art Journal.

Bookbinder.
Bookseller.
Brewers' Journal.
British Mail.
British Mercantile Gazette.
British Trade Journal.
Building Societies' and Land Companies' Gazette.
Building World.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette.
Dental Record.
Drinks.
Dyer and Calico Printer.
Educational Times.
Familiar Trees.
Furniture Gazette.
Gas Engineer's Magazine.
Giornale del Genio Civile.
Health Journal.
Inland Architect (Chicago).
Irish Textile Journal.
Leather Trades' Circular.
Machinery Market.
Manufacturers' Review and Industrial Record.
Marine Engineer.
Martineau & Smith's Hardware Trade Journal.
Meteorologische Zeitschrift
Midland Naturalist.
Mineral Water Trade Review and Guardian.
Moniteur Scientifique.
Musical Times.
Nautical Magazine.
Oesterreichische Monatsschrift für den Orient.
Paper Makers' Monthly Journal.
Photographer's World.
Plumber and Decorator.
Pottery Gazette.
Private Schoolmaster.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sanitary Record.
Science and Art.
Sugar Cane.
Symons's Meteorological Magazine.
Textile Recorder.
Textile World.
Ulster Agriculturist.
Union Horlogère.
Watchmaker, Jeweller, and Silversmith.
Wine, Spirit, and Beer.
Wine Trade Review.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

Quarterly.

Asclepiad, by Dr. B. W. Richardson, F.R.S.

NEWSPAPERS.

Belgian News.
Bombay Gazette (Overland Summary).
Ceylon Observer (Overland Edition).
Ceylon Times (Weekly Summary).
Eastern Post.
Empire.
Home and Colonial Mail.
London Commercial Record.
London and China Telegraph.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Sheffield and Rotherham Independent.
Times of India (Overland Weekly Edition).
West London Observer.

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